PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY, Limited,

167-176 TIMES BUILDING, NEW YORK.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 28 Hathaway Building, Boston.
Western Office, 465 The Rookery, Chicago.
Philadelphia Office, 927 Chestnut Street.

SUBSCRIPTION, IN ADVANCE, ONE YEAR $3.
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VOL. XX. NEW YORK, JULY 9, 1892. NO. 2.

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Honors to Sir William Thomson. A CABLE dispatch announces that the Berlin Academy of Sciences has conferred the Helmholtz gold medal on Lord Kelvin (Sir William Thomson). We feel sure that we are expressing the feelings of all American electricians in congratulating this eminent scientist in their behalf for the well deserved honor bestowed upon him. There are few, if any, living electricians who did such creditable work in the electrical field at a time when it was in its infancy, and when such research was far more difficult than it is now.

Statistics of the Telephone. THE first publication of the Census Department on the statistics of the electrical industries is given in another part of this issue. It relates to the telephone business giving in detail the aggregate figures for the entire country, and presents in every instance comparisons with the figures obtained in the Tenth Census, in 1880. A study of these figures will afford some interesting information as to the importance of the telephone as a factor in the commercial life of the present day. It is interesting to notice that, while the gross earnings have increased 12.75 per cent. per subscriber and the gross expense per subscriber has remained practically the same, the net earnings per subscriber have increased 54.68 per cent.

Rapid Transit in New York. AS is frequently the case, the engineering difficulties in a new enterprise are often easier to overcome than others outside of the province of engineering in the true sense of the word. In one of our recent issues it was stated that the Rapid Transit Commissioners' plans for an underground road, in which electricity would doubtless be used, were reported favorably, which means that the engineering difficulties in their opinion can be overcome. But now it appears that one of the elevated roads is about to add track facilities to its lines by which it can run express trains. This cannot fail to have its effect on the difficulty of obtaining the large amount of capital required for the underground enterprise. An overhead road is, of course, cheaper to construct than one that is underground, and the latter can therefore hardly compete with it unless aided by proper legislation in the interests of the people.

Protection of Telephone Lines Against Induction. IN a recently published article Mr. Strecker gives some interesting numerical data regarding the effects of lines carrying alternating and direct currents on those for telephone circuits; also those of another telephone circuit. The effect of one telephone circuit on another, he states, may be represented by the ratio .2; for a direct current of 100 ampères from a dynamo running at 600 revolutions and having 40 commutator strips it is 110, and for an alternating current of 70 ampères mean current and 80 periods it is 30,000. He states, furthermore, that a lead cover of a cable is an almost perfect shield against induction from without, as is also the surrounding earth in an underground cable. In a multiple cable the lead covering affords no protection against the induction of the various wires on each other. He claims that there is no method of running bare overhead lines by twist wiring or other similar means, which will perfectly protect the circuit against induction. Against a single strong current line wire there is no perfect protection, but when the lead and return are both equally distant from the telephone wire the latter is unaffected. Wires carrying multiphase alternating currents, if properly twisted, will have their effect reduced very much on neighboring wires, although the effect, he states, cannot by any means be entirely eliminated.

Detector for Hertz's Experiments. THE large amount of interest excited by the experiments of Prof. Hertz has induced many others to repeat them and to make further investigations. One of the results of this has been that a great number of different forms of detectors have been devised; some with the object of rendering the phenomena visible to a large audience and others with the view to making the detector very sensitive. Among the latter is one recently devised in which a tube is kept full of an explosive mixture of gases which will be ignited by the very smallest spark. It consists of a small glass tube partly filled with hydrochloric acid and having two platinum wires sealed into the lower portion; by means of a few battery cells the electrolysis of the acids keeps up a continuous supply of an explosive mixture of hydrogen and chlorine. In the upper part of the tube above the liquid two adjustable platinum wires are introduced, which are connected with the two parallel resonator wires; the spark from the latter explodes the mixture, and thereby gives evidence of its existence. To overcome the difficulty occasioned by a drop of the liquid forming between the upper wires, from the spray, these wires are connected to a battery which will be short-circuited by such a drop, and therefore immediately volatilize it, rupturing the circuit. If the latter battery be connected at a node it will not interfere with the phenomena.

Blowing Out an Arc. CENTRAL station men have always experienced considerably difficulty in blowing out or otherwise interrupting an arc that has once formed across the terminals of a burned-out fuse or between the two poles of a switch on the face of a central station switchboard. The importance of the switchboard as the centre of distribution makes it imperative that this should always be kept in first-class working order. Hence any arc formed at the switches must be promptly interrupted before it has had time to do much if any damage. The method of doing this suggested by Mr. Thomson in his article on "Central Stations," given elsewhere in this issue, by dashing dry sand against the arc is one which we think, is not very generally practiced in this country. It is doubtless an effective, as it certainly is a cleanly, way of accomplishing what the agile dynamo tender is often compelled to do with more or less disastrous results to his much abused hat. Mr. Thomson also directs attention to a number of other very practical points in central station construction and management that are the result of his own experience in this line of work, and for this reason they are especially deserving of careful attention. Many of our readers will take issue with him, however, in the preference which he gives to slow speed engines for all central stations of over 100-h. p. capacity. The continued erection of many plants in all parts of the country with high speed engines, driving dynamo units of from 200 to 300 h. p., may be taken as sufficient evidence that this type of plant has not yet met with disfavor among central station designers.

The Theory of Transformers. IN another column we publish an article by Prof. Rowland, of the Johns Hopkins University, well known for his researches in magnetism, in which he gives some general theoretical deductions regarding transformers. He claims that false conclusions arise from assuming the self and mutual induction of transformers to be constant. He treats the theory in a general way and takes into account the variations in the magnetic permeability of the iron and the hysteresis. He shows theoretically what he thinks the true explanation of the existence of the odd harmonics shown by Prof. Ayrton in the current curve of transformers, and attributed by Fleming to hysteresis. He concludes that a simple harmonic current through an iron transformer will produce a secondary electromotive force or current, or both, which contain not only the fundamental period, but also the higher harmonics, and claims that this effect is not due to hysteresis, but to the variation of the magnetic permeability. The harmonics increase with the increase in magnetization of the iron and nearly vanish with it, and therefore an increase of resistance will decrease the harmonics. He calls special attention to the fact that all formulæ by which self-induction is balanced by a condenser will be correct only when applied to an air transformer, but not to an iron transformer. In the latter they will apply approximately when the magnetization is small, and therefore probably apply better to transformers with an open magnetic circuit like the hedgehog, than with a closed one. He also claims that an iron transformer should not be compared with an air transformer, nor should iron transformers with different magnetization be compared with each other.

Electrical Books at the World's Fair. THE electrical exhibit at the World's Fair next year will be incomplete without a good display of the literature of electricity, from the time of Gilbert's famous work in 1600 to the present time. Although a few collections in this country, notably that of Park Benjamin, could furnish much material for a literary exhibit of this kind, the principal contributions to such a library as would do justice to the importance of the subject would doubtless be obtained from the shelves of private collectors in England and on the Continent. While it is doubtless the case that in a few instances some objection would be made to the transportation of valuable and rare books from foreign countries, it is highly probable that many collectors could be prevailed upon to each send a choice selection of books, which taken together would form an interesting and instructive history of the early ideas upon electricity and magnetism. The arrangement of Mr. Benjamin's collection at the rooms of the New York Electric Club, at the time of its exhibition last year, grouped in chronological order, with historical and explanatory notes, was an ideal method of systematically displaying a collection of this kind for educational purposes. If a similar arrangement could be made of books from the collections of the world, it would form a magnificent method of studying the chronological development of the ancient theories of electricity. The preliminary arrangements for such an exhibit might well be placed in the hands of a committee of the American Institute of Electrical Engineers, under whose direction such a display ought to be made. Other electrical societies in England, Germany and France could doubtless be induced to appoint committees to co-operate with the American committee, and to assist in securing liberal contributions from the collections of their respective countries. Very few of those who have taken up the study of electricity in the last ten years know anything of the extent of the literature of the subject of the last three centuries, and in no better way than this could an instructive object lesson be given.

High Speed Train Resistance. THE subject of increasing the speed of railroad trains by using rotary electric motors in place of the present reciprocating steam motors, which is daily growing to be more and more important, involves a knowledge of the train resistance at such high speeds. As theory is of little aid, we have to depend almost entirely on existing experimental data, which, however, is unfortunately very scarce and not free from errors. In order to arrive at a good mean result for use in such calculations, our contemporary, *Engineering News*, in an able article reprinted in our columns, compiles all the best existing data, makes some corrections and then plots them. From this set of plotted results a general law is then deduced by giving more or less weight to the various data, in proportion to their probable correctness. By this process, which is the only proper way to attack this problem, is obtained what is probably the nearest approach to the true rate of train resistance in pounds per ton that existing data enable one to deduce. The result, therefore, is of considerable interest to those working in this field, especially as it shows that the generally accepted assumption which states that the resistance increases with the square of the velocity, is probably incorrect. For steam locomotives, to which this article refers, there is a factor which enters into this total resistance, namely, the resistance due to oscillations and concussions, which certainly is quite considerable at high speeds, and if included in the total train resistance would doubtless make it increase more rapidly with the speed. But for electrical traction, in which there is only rotary motion, this factor in the total resistance becomes very much smaller, because a steam locomotive expends much energy in trying continually to get off the track, to spread the rails, to pound down the roadbed and to twist its frame. Although not pointed out in the article of our contemporary, yet it appears to us that the formulæ for electrical traction ought therefore to give lower results at high speeds than those for steam engine traction. The relative positions of the plotted values obtained for steam traction and those of Crosby made with electrical motors, seem to show this, as the latter form the extreme on one side of the mean. The results arrived at in this article, which refers to reciprocating steam motors rather than to electrical rotary motors, are that the train resistance is equal to one-quarter of the velocity plus two. This is certainly a very simple formula, and it would be very gratifying to find that it was correct. Further developments in this field may give different results, but until other experiments are made this formula may doubtless be used as the best one existing at present.

The Automatic Regulation of Water Wheels.

BY. F. E. PRITCHARD.

Since the application of water power to the driving of electrical machinery has been demonstrated a success, the subject of the automatic regulation of water wheels is one of importance to nearly every person interested in the electrical business. It is the principal objection that is offered to the utilization of water power in the operation of electric light and railway plants. The writer took this matter up as a special study about six years ago, and has made it a specialty in connection with actual practical work in the running of both lighting and railway work. In that time I have learned a great many points regarding water wheels and their regulation that may be of value to the reader.

In the selection of a wheel with a view to regulation, the principal matter to be investigated is the gate rigging. A wheel with a gate that has tendency to close by the action of the water or with its weight, is one that can be governed without any great difficulty under the ordinary conditions. The gate that requires a pressure to move it in either direction, no matter how slight, is one to be avoided. The former has a tendency to rest continually on the rigging and on the connections to the governor, thereby insuring a movement of the gate upon the slightest movement of the governor in either direction, whereas the latter stands until the governor has moved far enough to take up all slack in the rigging that must necessarily be there owing to torsion in shafts, back-lash in gears, etc.

With a wheel whose gate rests on the governor shaft, as mentioned, I have found little difficulty in governing in a satisfactory manner for arc and incandescent lighting or for textile fabric mills. In the electric railway field I have found that it is little short of an absurdity to expect to govern a wheel reasonably close. As in this line of work the load changes from full to nothing in less time than it takes to write the words, and as water is a solid to a great extent, it is not possible to automatically regulate it to comply with the sudden and wide range in load. In dealing with this question at Oswego, N. Y., I overcame the difficulty in a very satisfactory manner by the introduction of an automatically varied load which practically held the load on the generator constant. It consisted of a rheostat of iron wire of a capacity nearly equal to the gross output of the generator. At normal speed this was out of action, the full current being taken for cars. As the speed increased an automatic device gradually cut this rheostat into circuit, and by the time the speed was increased from five to seven per cent. there was as much current being absorbed by it as when all the cars were drawing current. By means of this driver, which is still in use, the regulation was accomplished in a very satisfactory manner.

The principal objection to using this scheme is that just as much water is consumed with light load as with full load, but as a rule where water power is cheap enough to be preferable to steam, this is not a serious drawback.

I have experimented some with a water wheel governor in connection with this device, but as a whole it has not been satisfactory. With the described device I found that all that was required was to open wheels to a point sufficient to carry the greatest number of cars to be used for the day. That point once reached, nothing more was required.

It was connected in such manner as not to interfere with the automatic circuit breakers, and in case of a short circuit on the line the regulator came into action and prevented any undue speed.

Use of the Arc Light in Ophthalmoscopic Examinations.

Recent experiments with the electric light in ophthalmoscopic examinations have been made, with the view of proving the efficiency of the same for that purpose, and highly successful results have been obtained, particularly with the arc light, the use of the incandescent lamp having been found to be impracticable. In the experiments made by one interested in the subject with the incandescent lamp, it is stated that the outlines of the glowing loop of carbon were reflected on the interior of the eye, giving only linear illumination and leaving the territory between and around their borders in comparative darkness. Increasing the amount of candle power and shielding the flame by means of a frosted globe lessened, but by no means obviated the evil.

A small arc light was then secured and experimented with, and as stated above the results were most satisfactory. The lamp used was of the Ward type manufactured by the Electric Construction and Supply Company, Telephone Building, New York. Five ampères of current were used, producing 500 c. p. when burning an arc of forty-five volts, a special carbon being used to give proper quality and color of light. A writer on the subject in a rescent issue of the Boston *Medical and Surgical Journal* further describes the adjustment and use of the lamp as follows: "A resistance coil, placed in circuit with the lamp and connected with it by a flexible cord, takes up the balance of the voltage. The lamp is held on a metal base which carries an upright on which is mounted the apparatus for adjusting the carbons and feeding them toward each other. This upright is provided with a shield, at one end of which is a slide in which ground glass may be inserted for the purpose of toning the light.

"The lamp may be connected with any incandescent circuit, it and its resistance being placed in the branch with a five-ampère switch. The branch on which it is placed should have a carrying power of six ampères. The lamp I am at present using occupies a space of about 6 by 9 inches. Its conductor being flexible, it can be readily moved about the table. The aperture in the shield is an inch and a half in diameter. Through this shines a brilliant and steady light that readily adapts itself to the needs of the observer. He can employ it for oblique illumination, use it with the mirror alone for testing the transparency of the media or for retinoscopy, or apply it to the examination of the fundus in either the direct or inverted image.

"Despite the character of this light, I find no unpleasant effect complained of by the patient. No complaint of dazzling has been made, and no greater inconvenience caused than would have been the case with the Argand gas-burner. I have no hesitation in stating that I find the light the best I have ever used. The color of the fundus approaches more nearly to that obtained under exceptionally favorable circumstances by day. The definition is greatly improved, being clearer than that obtained with any other form of artificial illumination. Repeated comparisons instituted between the Goddard gas-burner I have had in use for more than twenty years and the arc light show the superiority of the latter. This has proved to be particularly the case in certain forms of slight macular disorganization I have lately had the opportunity of examining. The careful and repeated scrutiny required when gas was used yielded to the certainty afforded by a single glance aided by the electric lamp. Slight haziness of the vitreous, as well as floating bodies and membranes in this portion of the eye, assume unusual distinctness.

"I cannot but think that when the arc light has been perfected for this purpose it will supersede all lamps now in use."

Notes on the Theory of the Transformer.*

BY HENRY A. ROWLAND.

As ordinarily treated the coefficient of self and mutual induction of transformers is assumed to be a constant and many false conclusions are thus drawn from it.

I propose to treat the theory in general, taking account of the hysteresis as well as the variation in the magnetic permeability of the iron.†

The quantity p as used by Maxwell is the number of lines of magnetic induction inclosed by the given conductor. This will be equal to the number of turns of the wire into the electric current multiplied by the magnetic permeability and a constant. But the magnetic permeability is not a constant but function of the magnetizing force, and hence we must write

$$p = B\,n\,y + C\,(n\,y)^3 + \delta\,(n\,y)^5 + \text{etc.},$$

where B, C, etc., are constants, n is the number of turns and y the strength of current.

In this series only the odd powers of y can enter in order to express the fact that reversal of the current produces a negative magnetization equal in amount to the direct magnetization produced by a direct current. This is only approximately true, however, and we shall presently correct it by the introduction of hysteresis. It is, however, very nearly true for a succession of electric waves.

To introduce hysteresis, first suppose the current to be alternating so that $y = c \sin (b\,t + e)$ where t is the time and e the phase. The introduction of a term $A \cos (b\,t + e)$ into the value of the number of lines of induction will then represent the effect very well. But the current is not in general a simple sine curve and so we must write

$$y = a_1 \sin (b\,t + e_1) + a_2 \sin (2\,b\,t + e_2) + a_3 \sin (3\,b\,t + e_3) + \text{etc.}$$

In this case it is much more difficult to express the hysteresis empirically. In most cases the first term in the value of y is the largest. A term of the same nature as before will, in this case, suffice to express the hysteresis approximated. We can then write for the total flux of magnetic induction

$$p = A \cos (b\,t + e_1) + B\,n\,y + C\,n^3 y^3 + \delta\,n^5 y^5 + \text{etc.}$$

Problem 1.—To find the electromotive force necessary to make the elastic current a sine curve in a transformer without secondary. Let the resistance be R, and make $y = c \sin (b\,t)$. Then Maxwell's equation becomes

$$E = R\,y + n\,\frac{dp}{dt}.$$

Substituting the value of y we have

$$E = (R\,c + A\,b\,n) \sin (b\,t + B\,n\,c\,b \cos (b\,t) + 3\,C\,n^3 \sin^2 (b\,t) \cos b\,t + \text{etc.}$$

But

$$\sin\ b\,t \cos b\,t = \tfrac{1}{4} (\cos b\,t - \cos 3\,b\,t)$$

$$\sin^4 b\,t \cos b\,t = \tfrac{1}{16} (\cos 5\,b\,t - 3 \cos 3\,b\,t + 2 \cos b\,t)$$

$$\sin^6 b\,t \cos b\,t = \text{etc.}$$

Hence the electromotive force that must be given to the circuit must contain not only the given frequency of the current, but also frequencies of 3, 5, 7, etc., times as many. In other words, the odd harmonics.

Problem 2.—Transformer without secondary, the electro motive force being a sine curve.

$$E \sin b\,t = R\,y + n\,\frac{dp}{dt}.$$

First it is to be noted that when we place in this equation the general value of y and make the coefficients of like functions, of $b\,t$ zero, all the even harmonics will strike out.

Hence the value of the electric current will be

$$y = a_1 \sin (b\,t + e_1) + a_3 \sin (3\,b\,t + e_3) + a_5 \sin (b\,t + e_5) + \text{etc.}$$

Substituting this value in the value for p, the equation is theoretically sufficient to determine a_1, a_3, etc., and e_1, e_3, etc. The equations are cubic or of higher order, and the solution can only be approximate, and I have not thought it worth while to go further with the calculation. However, it is easy to draw the following conclusion:

1. A simple harmonic current through an iron transformer will produce a secondary electromotive force and current, or both, which contain not only the fundamental period, but the higher odd harmonics.

2. This effect is *not* due to hysteresis, but to the variation in the magnetic permeability.

3. The harmonics increase with the increase in magnetization of the iron and nearly vanish as the magnetization decreases, although it is doubtful if they ever quite vanish. Hence, an increase of resistance will decrease the harmonics.

4. In the method of introducing the hysteresis into the equations, it enters as an addition to the resistance in the term $R\,a_1 + A\,n\,b$, where R is the resistance, a_1 the maximum current, A the coefficient of hysteresis, which is dependent upon the amount of magetization of the iron, n the number of turns of wire, and $b = \dfrac{2\,\pi}{T}$ is $2\,\pi$ divided by the time of a complete period.

The introduction of the hysteresis into the ordinary equations, therefore, presents little or no difficulty.

Many observers have noted that the current curve in a transformer was not a sine curve, and Prof. Ayrton has shown the presence of the odd harmonics, but gives no explanation. Mr. Fleming has attributed them to hysteresis, but I believe the present paper gives the first true explanation.

Problem 3.—To find the work of hysteresis. Let the resistance, R, be zero. The work done will then be the integral of the current times the electromotive force, or

$$w = \int y\,\frac{dp}{dt}\,dt$$

the integral to be taken for one period of the current.

$$w = \int_0^{\frac{2\,\pi}{b}} \left[A \sin (b\,t + e_1)\,y + B\,n\,y\,\frac{dy}{db} + C\,n^3 3\,y^2\,\frac{dy}{db} + \right] dt$$

$$w = A\,\frac{\pi}{b}\,a_1.$$

All the other terms are zero.

In a unit of time the energy absorbed is

$$\frac{A\,a_1}{2}.$$

Steinmetz has found by experiment that this varies as the 1.6 power of the magnetic induction. Of course the present theory gives nothing of this but only suggests a way of introducing the hysteresis in calculations of this nature. For this purpose replace A by $A^1 a_1^{.6}$ and the work of hysteresis becomes $\dfrac{A^1}{2}\,a_1^{1.6}$ which is thus the formula of Steinmetz.

In the case where a secondary exists the number of turns of wire being n^1 and the current y^1, we have simply to replace $n\,y$ in the above formula by $n\,y + n^1 y^1$ and change the phase of the hysteresis term so as to be 90 degrees from the combined magnetizing force, $n\,y + n^1 y^1$. The equations of the currents will then be, by Maxwell's formula,

$$E = R\,y + n\,\frac{dp}{dt}$$

$$O = R^1\,y^1 + n^1\,\frac{dp}{db}$$

Which suffice to determine both y and y^1. The result is too complicated to be attractive. The equations show, however, that the odd harmonics must appear in either the electromotive forces or the primary or secondary currents, if not in all of them at once. The exact distribution is only a case of complicated calculation.

It is to be specially noted that all formulæ by which self-induction is balanced by a condenser will not be correct when applied to an iron transformer, but only to an air transformer. They will, however, apply approximately to iron transformers in which the magnetization is small, and thus probably will apply better to transformers with an open magnetic circuit than with a closed one.

Also an iron transformer should not be compared with an air transformer or two iron transformers with different magnetizations with each other.

In conclusion I may add that the mathematical difficulties might be overcome by another mode of attack, but other work draws me in another direction and I leave the matter to be worked up further by others.

* From the Johns Hopkins University circulars.

† The problem is treated by the method of magnetic circuit first applied by me to iron bars in my paper on "Magnetic Distribution" (Phil. Mag., 1875), and afterward to the magnetic circuit of dynamos at the Electrical Conference at Philadelphia, in 1884. I also used the same method in my paper on magnetic permeability in 1873.

Test of the Neversink Mountain Electric Road.—VII.*

BY HERMANN S. HERING AND WILLIAM S. ALDRICH,
OF JOHNS HOPKINS UNIVERSITY.

VII.—SPECIAL CAR TEST.

Outline of Test.—Observations were made to determine the distribution of power, and the several losses from the hydraulic power supplied to the turbines, to the available power at the car axle, during the run of a single car over the usual route. This car, equipped with Weston ammeters and voltmeters, was operated as a special test car while no others were on the road. The motors on this as well as the other Neversink cars were 25 h. p. Edison, single reduction No. 12, style "B" motors, having been originally style "A' and rewound for this road. The run was continuous from Klapperthal to Ninth and Penn streets, by way of the Short Line, and returning by the route over the mountain. Only such stops and changes of speed were made as the junctions and turnouts required, making the time for the round trip somewhat less than that called for by the schedule. Readings were taken on the car every minute and intermediate changes were noted and timed to seconds; while the location of the car on the road with respect to grades, turnouts, junction, and other prominent points was also recorded. With the exception of going down grade, crossing switches and turnouts and a few obstructions in the city limits, the car was run with the switch on the seventh point, which is the condition for maximum speed and efficiency. The speed of the car was obtained by timing its arrival and departure at known points along the road. This gave of course the mean speed for that interval, and usually included the time lost in getting under headway and slowing up, so that this average is much below the steady running speed.

In the station, readings were taken at the turbines and the switchboard in the same way as during the test of the power plant, which has been already described. These observations to determine the station performance during the run of the test car over the road were taken under somewhat different conditions to those existing during the test of the power plant. In the station test both dynamos were used and were regulated for equal output, but in the car test only one dynamo was used. The turbines during this car test were set, the one at a fixed gate of 17.4 per cent. and the other controlled by the governor, which is the usual way in which these coupled turbines are operated for light, variable loads. This method of operating turbines, as distinct from that under heavy loads (in which each is independently governed), gave rise to peculiarities in their performance during this car test which are interesting, and will be referred to later on.

Car Route Data.—The profile of the road shown in Fig. 9 and the car route and road data given in Tables IV., V., VI. and VII. (THE ELECTRICAL WORLD, page 395-6, June 11, 1892), have been arranged in what has been termed a "car-route profile," shown in Fig. 22. Though the passenger route begins at Ninth and Penn streets, the special car started from the Klapperthal car house, but the round trip was made in the same direction as that of the regular passenger cars. This car-route profile, as distinct from the road profile, shows all the successive grades and distances over which the car passes during one round trip. Those portions of the road, as from the White House level through the city limits to Ninth and Penn streets and return, portions which are thus successively passed going and returning, are plotted in a continuous profile; the down grades for the trip going are, of course, the up grades for the trip returning. The sections of the road which are passed over but once during the round trip, as the Short Line and the route over the mountain from the north to the south side, are plotted in profile in the order of their succession along the route. The turnouts and switches are located in a diagrammatic way above the points along the distance base of the profile in their respective positions. Reference has already been made to the excessive number of turnouts along the road, and the delay caused by the necessary slowing up while passing them. Cars are run at not less than fifteen minute intervals, though more frequently at twenty and thirty minute intervals; but the turnouts are evidently located for such service as is called for in three minute intervals on a street car road.

The road being largely composed of curves, outside the city limits, renders it interesting to represent them in succession along the car route. They have been plotted in a diagrammatic manner above the line of turnouts of Fig. 22, on the distance base of the profile below, with their ordinates representing the degree of curvature (the arc subtended by an hundred-foot chord). Thus No. 7 turnout, which is located at the extreme eastern end of the mountain loop (see Fig. 8, THE ELECTRICAL WORLD, June 11, 1892), is shown on Fig. 22 to be on a 35-degree curve, which extends for a distance of 350 feet. No attempt has been made to represent the direction of the curve nor to indicate the points of reversal; that is, whether the curve is a reversed curve or not, but simply to show the length of the curves and how sharp they are. By referring to the map Fig. 1 (THE ELECTRICAL WORLD, May 28, 1892), and to Fig. 22, it will be seen that between the Upper Junction and the trestle, on the steep declivity on the south side of the mountain, there is quite a continuous succession of curves, almost all of which are reversed. Straight portions of the track are, of course, represented on the base line extending for their corresponding length.

The mean car speed in miles per hour, between the observed points along the road, has been plotted on the same base as the profile in Fig. 22, and shows the speed of the car for corresponding portions of the road. Thus, the run over the Short Line from the Upper Junction to the Lower Junction, a distance of 4,200 feet, was made in 4 minutes and 15 seconds, giving an average speed of 11.2 miles per hour, as plotted in the speed diagram for this section. On rounding the Highland House curve, at No. 9 turnout and on a 1.35 per cent. grade, a length of 525 feet, the mean speed was six miles per hour. The highest speed is usually made in crossing the mountain from the Summit to the Highland House (see map Fig. 1, THE ELECTRICAL WORLD, May 28, 1892), as the road is down grade and contains a large portion of straight track; and in this case from No. 8 turnout to the grade change at No. 9 turnout the speed was 21.2 miles per hour, as plotted in the curve. The highest speed up grade, 15 miles per hour, was obtained on the 3.64 per cent. grade between No. 11 turnout and the Upper Junction; and the best time up grade is usually made on the stretch between the car house and the Upper Junction, which in the case of this test was 11.75 miles per hour. This distance was covered in 9 minutes and 30 seconds, and included the slowing up over the trestle and turnouts, and while rounding several sharp curves.

The table at the foot of Fig. 22 contains the scale of miles for the profile, etc., and for the several grades and sections. The speeds are given between the principal stopping places and in some cases include both up and down grades, as within the city limits.

Hewitt's Speed Curves of the Neversink Mountain Electric Road.—Mr. Chas. Hewitt, of the Edison General Electric Company, went over the road June 24, 1891, in a special car equipped with ammeters, voltmeters, and a Boyer railway speed recorder.* The speed record of this test is shown in Fig. 23, having been kindly furnished by Mr. Hewitt for publication in connection with the test of the road made by the writers, as they were not able to obtain a Boyer recorder at the time. In a former issue† Mr. Hewitt has presented three sets of speed curves taken by a Boyer recorder in an article on "Speed of Electric Cars in City Streets."

Such graphical records, showing all the variations of the speed of electric cars, as in city or suburban service, are extremely valuable in showing the capability of the electric motor to attain its normal speed in short distances. Mr. Hewitt's curves from the test of the Buffalo cars on Hertle avenue with No. 10 Edison motors, show that an electric car can reach a speed of 15 miles per hour within a distance of 350 feet from full stop on an almost level track with a load of 27,000 pounds (20,000-pound cars). The speed record of the Neversink road on a 3.64 per cent. up grade and a load of 20,000 pounds shows that the car with No. 12 "B" Edison motors attained a speed of 10 miles per hour in 260 feet in one case, and 12 miles per hour in 300 feet in another instance. It might also be interesting to note that in returning over this same grade, the car going down attained a speed of 17 miles per hour in 460 feet from a full stop at the Highland House. The authors have integrated the curves of Fig. 23 for the different grades, and placed the values in the line below the respective grades, in order that they may be used in connection with their car route profile and curvature plot in Fig. 22. They have also plotted the turnouts of the road on Mr. Hewitt's curves, Fig. 23, as the speed variations at these points are quite marked. The values for the ampères and volts given with the speed curves are from Mr. Hewitt's tests.

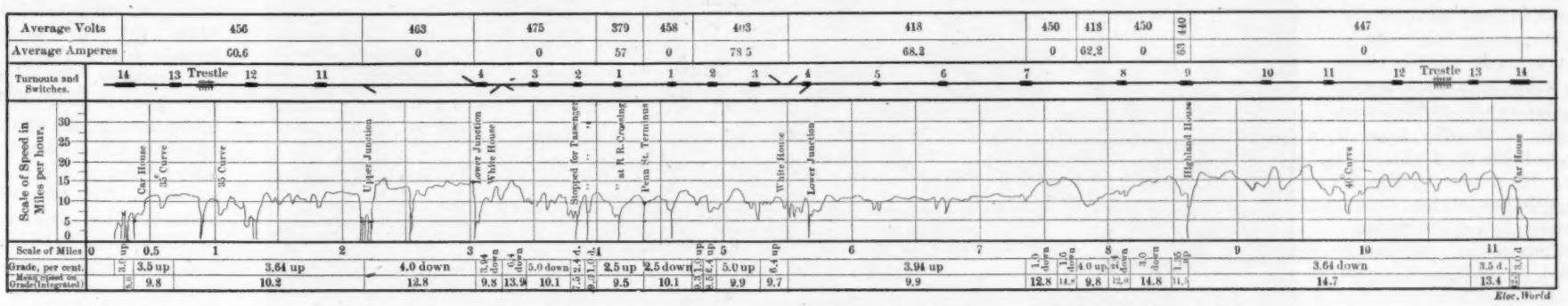


FIG. 23.—HEWITT'S SPEED CURVES OF THE NEVERSINK MOUNTAIN ELECTRIC ROAD.

Test of Car No. 2, equipped with two No. 12 Edison S. R. 25-h. p. Motors, Style B; weight of car, about 20,000 lbs. Speed diagram made by Boyer railway speed recorder, for entire car route, June 25, 1891.

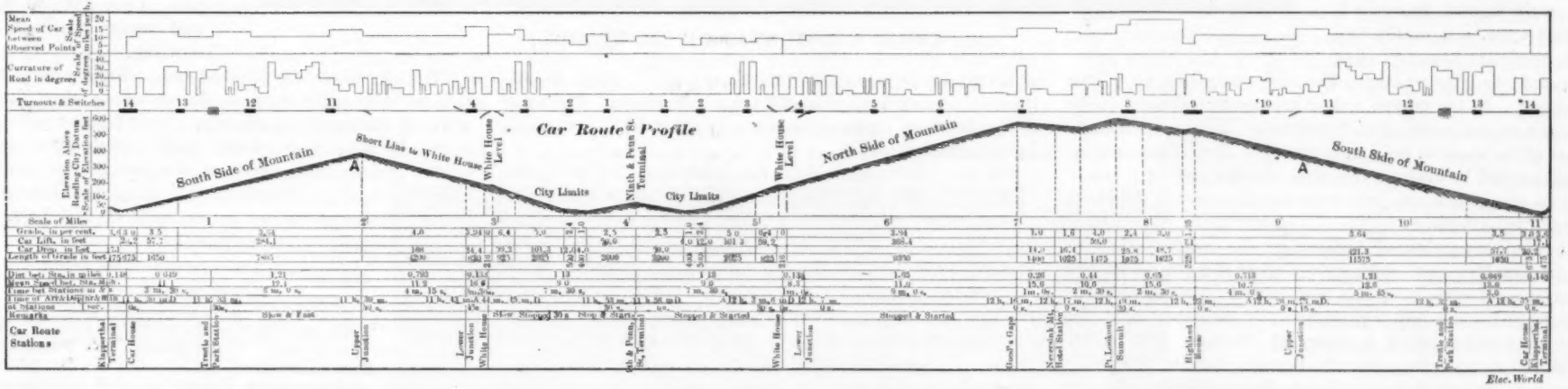


FIG. 22.—CAR-ROUTE DATA OF SPECIAL CAR TEST. ROUTE, PROFILE, TURNOUTS, CURVATURE AND MEAN SPEEDS.

Series-Parallel Electric Traction.

A test was recently made by the West End Street Railway Company, of Boston, to determine the relative efficiency of the series-parallel method of control as applied to electric cars, the results of which are published in the monthly bulletin of the railway department of the Thomson-Houston Electric Company. A comparative test was made between two cars, one equipped with the ordinary rheostat and the other with the Thomson-Houston type of controller, which was described in THE ELECTRICAL WORLD of June 25, 1892. The length of the route over which the two cars ran was 5.72 miles. The car equipped with the rheostat weighed 21,500 pounds, and made nine round trips at an average speed of 5.84 miles per hour, while that equipped with the controller weighed 21,650 pounds and made eight round trips at the average rate of 5.4 miles per hour. The former consumed 10,730 watt hours, with an average electrical horse power per round trip of 13.5, while the latter consumed but 7,588 watt hours, and required but an average of 9.5 electric horse power per round trip. The car with the series-parallel method of control thus required only 70 per cent. of the power used by the car with the rheostat, a saving of 30 per cent.

*For the first six sections of this article see THE ELECTRICAL WORLD of May 28, June 4, 11, 18, 25 and July 2, 1892.

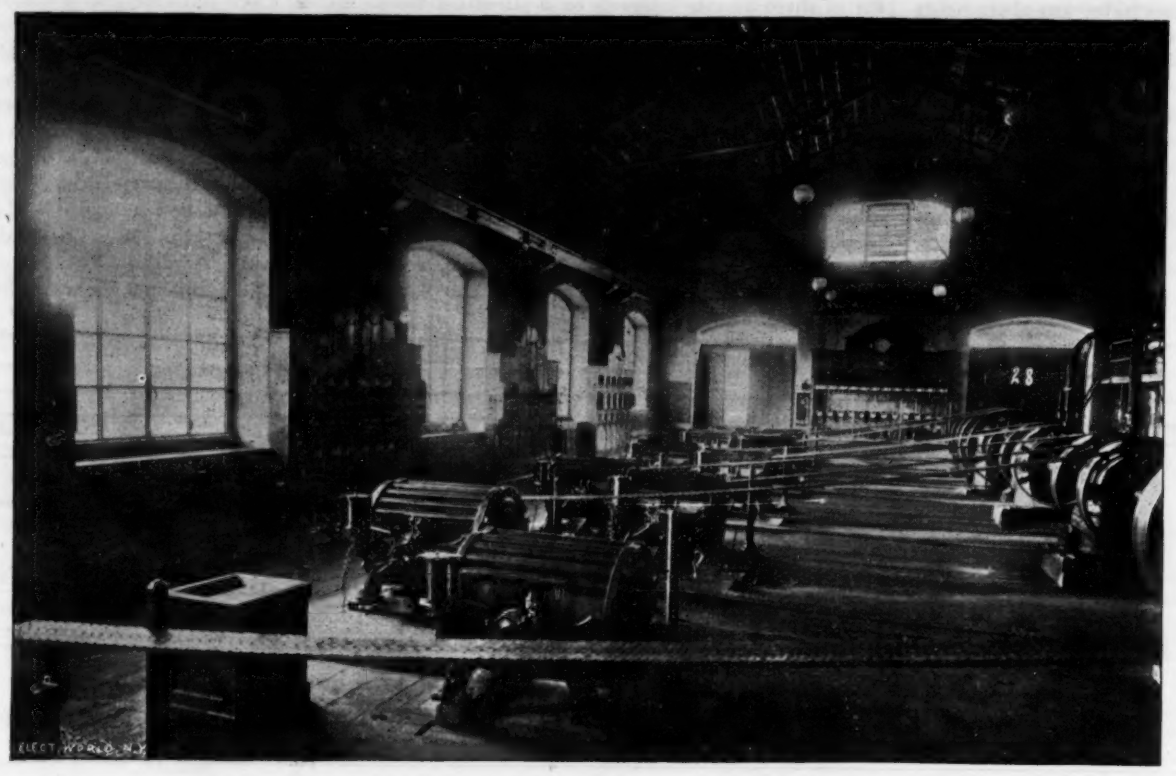
* For a description of this instrument see THE ELECTRICAL WORLD, April 18, 1891.
† THE ELECTRICAL WORLD, Dec. 15, 1891.

Electric Lighting in Milan.

(From a Special Correspondent.)

The most important by far of the two stations of the Societa Generale di Elettricita in Milan is that on the via Santa Radegondo. In past centuries the site was occupied by a monastery, vestiges of which still remain in the low outbuildings, which are now used for workshops and storerooms. On the walls therein may still be seen religious frescoes, some of which are very well preserved. These relics of ancient times are in striking contrast to this modern electric light station. When digging the foundations for the new building many tons of human bones were unearthed.

The engines, representing some 3,500 h. p., are in the basement of the station. There are nine of the Armington-Sims type, three of the Porter-Allen make, and two that were built by Gans, of Budapest. The dynamos are of the Edison make, having an output of 750 ampères and 115 volts at 350 revolutions, with the exception of the two Ganz alternate current dynamos, which have a capacity of 40 ampères and 2,000 volts. The dynamos are attached to the engines by means of a T-joint, Oldham type, permitting almost any difference of level between the machines. The Santa Radegondo station supplies nearly 22,000 lamps, ranging all the way from 10 c. p. to 100 c. p., the majority being 16 c. p. Of the arc lamps on low tension circuits there are 571, representing a total number of ampères installed of 12,714. The number of ampère hours produced during the year 1891 exceeded seven millions.



ELECTRIC LIGHT STATION IN MILAN.

The boilers, which are all of the well known Babcock & Wilcox type, are on the first floor; there are four groups of two, and two isolated ones. The feed water is drawn from two wells. In the engine room are water storage tanks having a capacity sufficient for 24 hours' run. All the elements of the station, boilers, engines, feed appliances, etc., are connected in multiple so that should any unit meet with an accident it can be cut out and the service continued without interruption.

The ancient republic of Andorra on the southern slope of the Eastern Pyrenees, with a population of 8,000, has never yet seen an electric lamp or a gas burner, although it has unsurpassed water power privileges; on the other hand, the little semi independent territory of Monaco and Monte Carlo has more active electric lighting plants than any country in Europe in proportion to its population, having three central stations besides two gas works in operation with a population of only 10,000. Paris has a surprisingly small number of electric lights; Nice with a population of 100,000 has not a single electric lamp for public lighting and very few for private lighting; Toulouse has probably the best system of incandescent lighting in Europe, but Milan is considered the best arc lighted city on the Continent.

The street lighting in the city of Milan is supplied from a separate station situated about 1¼ miles from the centre of the city. The station has a capacity of 460 2,000 c. p. arc lights. At present it contains four dynamos of 50-light capacity, four of 35-light and four of 30-light, all of the well known Thomson-Houston make. These dynamos are driven in sets of two by Armington & Sims engines, of which two are 90 h. p. and four 60 h. p.

Steam is furnished by Babcock & Wilcox boilers at a pressure of 125 pounds. The feed water, which is taken from two wells, is fed through a feed water heater by a duplex steam pump, or by injectors. The steam pipe is continuous, forming a complete closed circuit, into which the five boilers deliver steam, each boiler having a separate valve and being separated from the others by stop valves in the main pipes. All the connections are in multiple arc, so as to prevent the possibility of a failure of any one unit injuring the service. The exhaust pipe from the chimney passes through the smoke flue and through a cast iron pipe nearly to the top of the chimney. All the steam piping is covered with asbestos and cork. The station has a water meter and two scales, one of which serves to weigh the total coal delivered to the station and the other the coal heaped in front of each boiler.

All of the wiring in the interior of the station is carried under the pavement in lead covered insulated conductors. The main switchboard has a system of connections so arranged that when the current is taken off the circuits a low tension battery current is circulated through all the light ting circuits in series. In case any circuit becomes opened, or a low resistance ground manifests itself, a gong is rung through a relay notifying the person in charge of the station, who then advises the central office, and immediate investigation is made.

The street lighting in Milan comprises some 300 arc lights, of which about half remain lighted until midnight and the other half until morning. In addition some 35 lights are furnished to the central railroad. The Edison station can also supply 30 additional lights for extraordinary occasions.

The lamps are, as a rule, suspended over the middle of the street, with the globes about 25 to 30 feet above the pavement, and at distances of from 200 to 250 feet apart. Some 60 lamps are mounted on ornamental cast iron columns. These columns have a door in the front, in the opening of which a short circuit switch is disclosed, allowing the individual lamp to be disconnected from the main circuit. Of the 70 miles of conductors supplying the street lights about 10 are underground. The overhead wires are run along the house fronts, under the eaves, on brackets projecting out 2½ to feet from the wall, thus giving a strong support for the wire, and presenting at the same time a neat and practica solution of the difficulties attending overhead construction. The municipality has the right to compel property owners to allow these brackets to be affixed to the eaves for the use of the public lighting service.

The overhead circuits are No. 8 B. W. G. heavy rubber insulated conductors, while the underground conductors are Siemens lead covered and iron tape armored cables having an insulation resistance of over 10,000 megohms per mile.

The lamps are alternately connected to the midnight and all-night circuits, and at midnight every other lamp is extinguished. The lamps are suspended from steel cables which span the street. They are trimmed from aerial ladders as soon as they are turned off. Three ladders with three men to each ladder are sufficient to re-carbon all the lamps in four hours' time.

The famous Galleria Vittorio Emanuel and the square in front of the renowned Duomo are lighted by arc lamps, the cupola of the former having a powerful 6,000 c. p. arc lamp, which gets its current from the Edison station.

The electric light was first put in operation in Milan in 1886, and the confidence created by good and regular service is evidenced by the fact that nearly all the gas lamp posts have been removed from the streets, which are now lighted by arc lamps. The Milanese are well pleased with the service, and refer with pride to the generally acknowledged fact that Milan is the best lighted city on the Continent.

A Turbine Power Plant.

The accompanying illustrations represent the power plant of the Boston and Great Falls Electric Light and Power Company, Great Falls, Mont. The plant consists of horizontal Victor turbines with Rice patent friction pulleys and grooved pulleys for rope transmission, and was furnished by the Stilwell & Bierce Manufacturing Company, of Dayton, O.

In the foreground of Fig. 1 is seen a pair of 22½-inch Victor turbines operating together in one flume, that under a 40-foot head develop 392 h. p. They furnish power for an electric railway. The middle pair are 20-inch turbines, both placed in one flume, but operating independently, each wheel being provided with a governor. This pair develop about 320 h. p., and are used for commercial lighting. The last pair, which are shown more in detail in Fig. 2, are 22½-inch Victors operating independently in one flume with governors like the second pair. They develop 392 h. p., and supply power for street lighting.

The power is transmitted by belts directly from the friction pulleys on the shaft to the dynamos, thus dispensing with all intermediate gearing. Each friction pulley is operated by a hand wheel and shaft which terminates in a pinion gearing into a rack on the sleeve. The plant is very complete in all its details and is arranged so that any dynamo can be started or cut out at will. It has been in successful operation for some months.

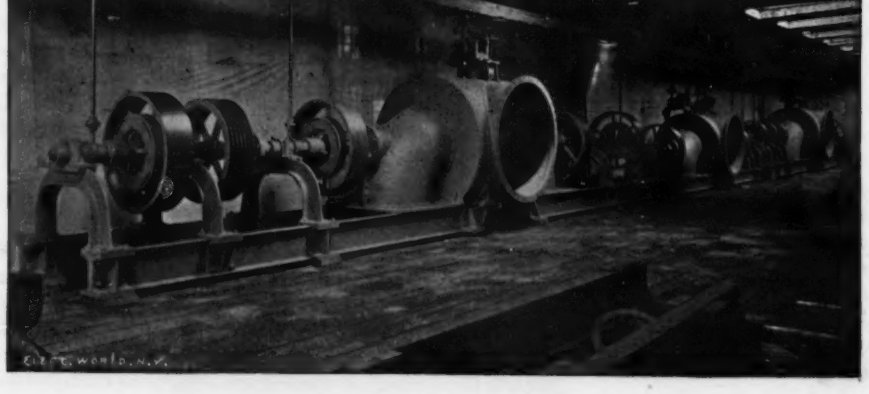


FIG. 1.—TURBINE POWER PLANT.

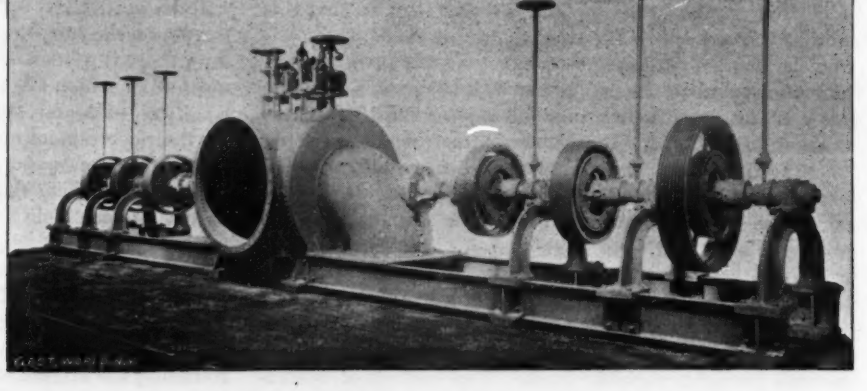


FIG. 2.—TURBINE POWER PLANT.

NEW BOOK.

Bericht Ueber die Verhandlungen des Internationalen Electro-Techniker Congresses zu Frankfurt-am-Main. Erste Haelfte Bericht ueber die Hauptversammlungen. Johannes Alt, Frankfurt-a.-M.. Germany, 1892. 182 pp. Paper.

This book, just published, is the first volume of the complete stenographic report of the proceedings of the last International Electrical Congress, which was held in Frankfort, Germany, in September of last year. It is a report of the general sessions, including a record of all the business which was transacted, and is presumably to be followed by a second volume, containing the proceedings of the five different sections into which this congress was divided. The first part contains a list of the foreign members of the General Congress Committee, followed by the programme of the meetings, and a list of the papers read at the general sessions and at those of the five sections. Following this is a list of the officers, delegates and the 715 members who were present, of which 243 were foreigners. A complete stenographic report of all the speeches, papers, discussions and business transactions of these general meetings forms the body of the book.

The papers which were read are as follows: "The Functions of Electrical Test Laboratories," by Dr. Epstein. "Symbols, Nomenclature and Conventional Signs in Electrotechnics" (in French), by Prof. Hospitalier. "The Educa-

tion of the Electrical Engineer," by Dr. Kohlrausch. "The Introduction of a Uniform System of Screw Threads," by Dr. Loewenherz. "Rules and Regulations for Electrical Wiring from the Standpoint of Insurance Companies," by Dr. May. "The New Domain of Alternating Currents," by Prof. Silvanus P. Thompson. "Electrical Railroads for Rapid Transit between Cities," by Mr. Zipernowsky (translated and reprinted in THE ELECTRICAL WORLD of Oct. 10, 1891, page 269).

There was very little business of an international character transacted at this congress. A general system of notation was adopted, as also a uniform set of letters for representing the seven chief electrical units. At the end of the volume there is a short record of the social features which formed such an interesting part of this international meeting of electricians.

Some Special Features of the Central Stations of the Louisville Electric Light Company.

BY H. K. HITCHCOCK.

The completion of the new station of the Louisville Electric Light Company adds one more to the already large number of electric lighting stations owned and operated

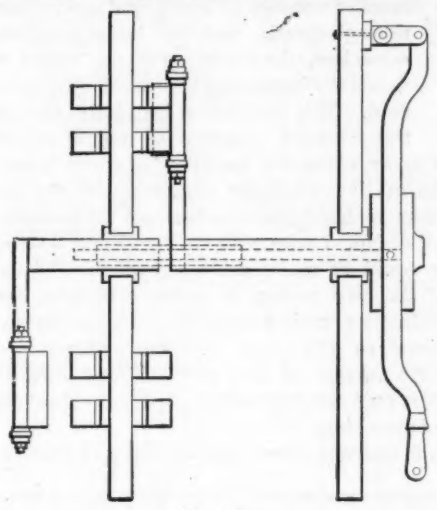


FIG. 1.

by gas companies. A brief description of the magnitude of the new undertaking and methods employed to reduce as far as possible the cost of making and distributing the electric currents for light and power may prove of interest.

In the boiler room stands a row of Babcock & Wilcox boilers fed by Roney stokers. Running along in front of the boilers is a railroad track, upon which the coal is brought by means of dump cars. After being weighed it is then dumped through a trestle into the basement and from there elevated to the coal bins above.

From here it is brought to the front of the boilers by means of wrought iron spouts, so that the cost of handling the fuel is reduced to a minimum. The ashes are dumped into cars below which are rolled out and dumped into a pit, from whence they are elevated, in the same manner as the coal, into cars placed on the track above, and hauled away.

The steam is conveyed from the boiler into the engine room by means of independent wrought iron pipes, which discharge into a

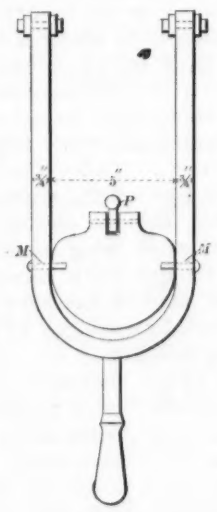


FIG. 2.

system of riveted wrought iron pipes, so connected and supplied with valves that almost any portion of the system can be removed and repaired without cutting off the supply of steam to the engines which are situated on the first floor of a three-story fireproof building joining the boiler house.

The motive power is furnished by four compound condensing Hamilton Corliss engines, three of which have a nominal horse power of 750 each, the fourth being of 250 h. p., and designed to run the day load. Four large double belts drive the line shafts, which are securely fastened to the iron girders on the third floor, and which drive the dynamos on the second floor.

The water for the condensing and steam plant is pumped from a large well up into a tank by a pair of compound condensing pumps sunk into a shaft.

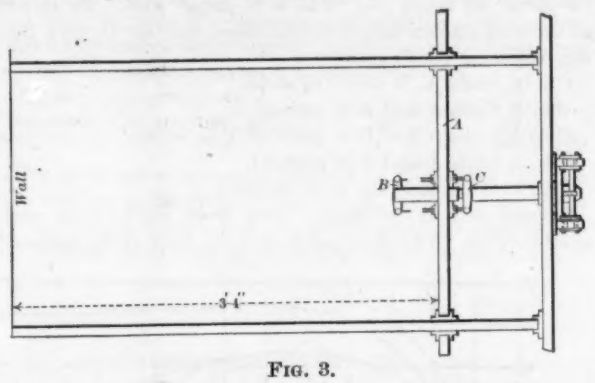


FIG. 3.

The arc currents are distributed by means of a large switchboard made by the Fort Wayne Electric Company, and supplied with lightning arresters and ammeters to indicate the quantity and direction of the current. A series of incandescent lamps are introduced in the different circuits, so that during the day should the circuit open the lamps will be extinguished, thus notifying the attendant who has the trouble rectified.

The current from the alternating dynamos is distributed

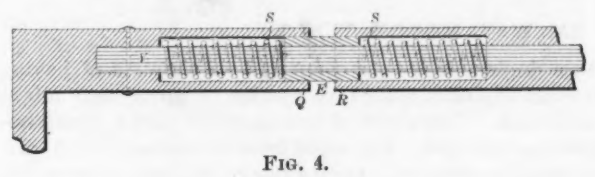


FIG. 4.

by means of a switchboard of my own design, and the method is a broad departure from that previously employed.

Fig. 5 is a perspective view of the switchboard, and Fig. 3 a sectional view. It consists of six panels each two feet wide and eight feet high, made of Tennessee marble carefully selected for high insulating quality, upon which are mounted the various measuring instruments, switches and rheostats, each circuit being provided with an ammeter and each machine with a voltmeter and ammeter.

Fig. 1 is a plan of part *A* in Fig. 3, while Fig. 7 is a detail of the contacts shown in Fig. 6. The part *B* is connected through to the front of the board by means of *I*, as shown in Fig. —, and joined to the flange *K*. In Fig. — is shown a front and side view of the actuating lever *L*, and

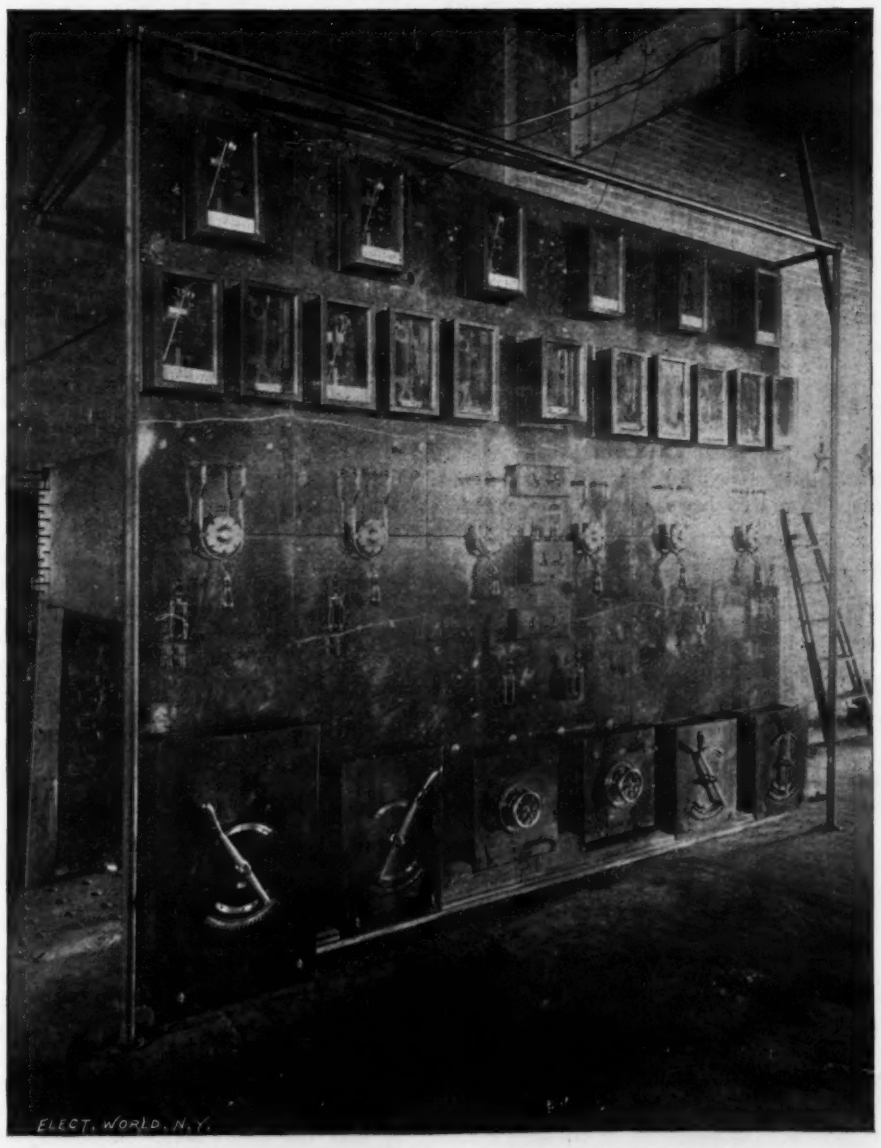


FIG. 5.—ALTERNATING CURRENT SWITCHBOARD.

it will be noticed that a rocker is pivoted at points *M* and *N* so as always to be vertical, no matter what the position of the handle *O*, and provided with a dog, *D*, to engage the flange *J* and *K*.

In the flanges *J* and *K* slots are cut at such places around their circumference that when engaged by the dog *P* the contact pieces *B* and *C* will be opposite the set of contact points 1, 2, 3, 4, 5, 6, 7 and 8, shown on plan in Fig. 6. These slots are all numbered on their faces so as to indicate whether machine No. 1 or No. 2 or No. 3, etc., will be engaged with the circuit when the dials are in any given position.

The dynamo terminals are connected to the outside row of contact points in Fig. 6, as indicated by the numerals, dynamo No. 1 being at the top and Nos. 2, 3, 4, etc., following in regular order to the right around the circum-

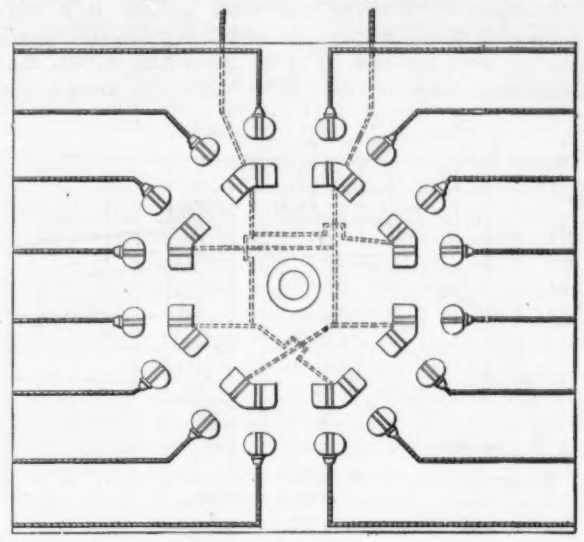


FIG. 6.

ference. The other contact points are connected as shown by the dotted lines. The wires connecting one pole of the circuit are on one side of the plate *A*, and those connecting the other pole on the other side of *A*, as will be readily understood by reference to the figure.

Suppose, now, that the circuit is connected as shown in Fig. 5, with machine No. 1, and it is desired to transfer this circuit to any other machine in the station. The plate is revolved on its axis until the slot bearing the number of the machine to which it is desired to connect the circuit comes opposite the dog *P*, when the dog is pulled forward, holding the dial *J* firmly in place. This movement of the dial *J* has been followed by a similar one on the part of contact piece, so that it is directly behind the machine corresponding to the number on the dial *J*. Now, all that is necessary is for the attendant to pull out the lever *O*, when the contact piece *B* will begin to move toward the contact points on the back of the plane *A*. The friction between the contact piece *O* and the contact points which it engages will prevent any movement on the part of the former until the shoulder *C S* reaches the shoulder *R*. But during this time the springs *S S*, which are shown in detail in Fig. 4, will be compressed; as soon, however, as *Q* and *R* meet, *C* will begin to move in the same direction as *B*. and when *B* is within one quarter of an inch of the contact points *H H*, the contact will break between contact piece *C* and contact pieces which were previously engaged. This will allow the expansion of springs *S S*, which will throw the contact piece *C* away from the circuit quickly, preventing any possibility of arcing. By this time contact piece *B* has engaged contact pieces *H H*, and the circuit will be transferred to the desired machine. The next transfer will be made by locating dial *K* in like manner and reversing the motion of lever *O*.

The mains of the two exciters run across the

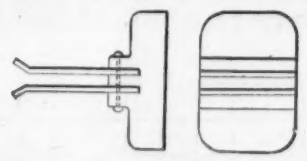


FIG. 7.

entire width of the board, and are connected to double pole double throw switches placed above the rheostat of the different alternating current machines so that by means of reversing the switch handle the field may be cut on to either one of the exciter circuits. In the centre of the board is a standard voltmeter so connected by a multipolar switch that any of the instruments may be tested and standardized. A similar switch connects each one of the circuits to the ground circuits, thereby enabling a complete and thorough testing of the system. A making of each circuit, independent and complete in itself, as accomplished by the switch, greatly simplifies the connection, and makes it impossible for the attendant to get two machines connected together, or to make other serious mistakes, which otherwise might occur. It allows extension to meet the requirements of the station to be made without complicating the connection. It is sufficient to say that the switch, as shown in the illustration, has a capacity for 7,800 incandescent lights, and can be extended by means of an addition of more panels, each two feet wide, to an ultimate capacity of 24,000 lights. It requires no great skill to manipulate it.

Electric Railway Motor Tests.*

BY PROF. GEO. D. SHEPARDSON AND EDWARD P. BURCH.

The experiments here discussed were undertaken for the purpose of obtaining definite information about the performance of electric railway motors under various conditions. There is a diversity of opinion about the relative merits of regulation by rheostat and by commutated fields, the use of one or two motors on a car, value of wetting rails, causes of "bucking" and other points. It is commonly understood that electric roads using rheostat regulation require larger capacity at the generating station than those using the commutated fields. It is also known that one large road has substituted rheostat regulation for commutated fields on all its motors. One large road has reduced the pressure on the lines to a figure considerably below 500 volts, with marked reduction in the repair bill.

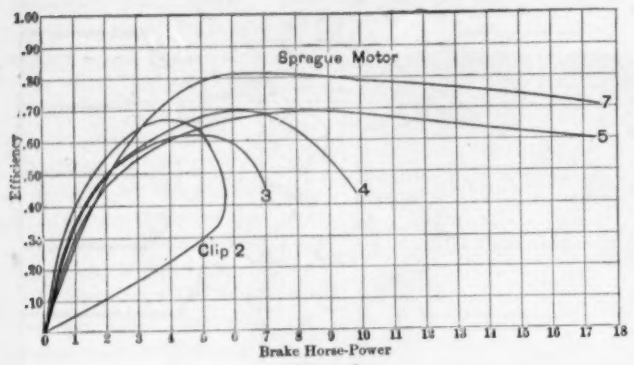


Fig. 1.

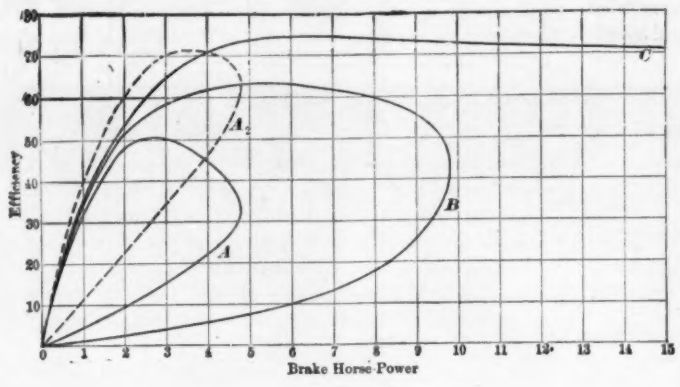


Fig. 2.

SOME CURVES OF RAILWAY MOTOR TESTS.

Much has been said and written, but the data published are meagre and in some cases misleading. It was therefore thought desirable to obtain data from careful tests under working conditions in the hope of substantiating some of the claims made and of bringing out some new facts. The tests were conducted for the most part by Mr. Edward P. Burch, a senior in electrical engineering in the University of Minnesota, in connection with his graduating thesis, and by courtesy of the Minneapolis Street Railway Company, especially the master mechanic, Mr. William Cooper. Most of the tests were made upon a No. 6 Sprague double reduction motor of the type described by Mr. H. F. Parshall before the Institute May 21, 1890, and April 19, 1892. Some experiments were also made upon a single reduction motor. Each machine is used at the repair shop for testing armatures, being anchored to a heavy crib sunk eight feet into the ground. Each car axle is replaced by a short shaft carrying a heavy cast iron wheel with solid web, upon which two oaken blocks are bolted for use as a brake. This was made into a Prony brake by removing the angle irons that held it to the floor and bolting on a plank to which an iron plate was fastened, so as to give a knife-edge bearing at a distance of 63.1 inches from the centre of the shaft. This plate rested upon a knife edge supported upon platform scales by which the turning moment could be measured. The mechanical horse power delivered at the car wheel is

$$\text{H. P.} = \frac{2\pi RPN}{33{,}000} = \frac{PN}{1{,}000},$$

in which P is the pressure on the scales, N the revolutions of the car axle per minute. The speed was measured by a common speed indicator with soft rubber tip to prevent slipping. For slow speeds a stop watch was used, the time for five revolutions of the car wheel being noted. Current and potential were measured by new Weston instruments, about 12 feet distant from the motor.

The Sprague motor armature has 56 sections of eight turns each of No. 12 B. & S. gauge wires. The speed reduction ratio is 11.765. The field coil as used at first was in three sections, coil A 700 turns, coil B of 820 turns, and coil C of 620 turns, all being No. 12 B. & S. gauge wire. By means of the well known barrel switch these coils are thrown into the following combinations:

Clip 2, Coils A, B and C in series.
Clip 3, Coils A and B in series.
Clip 4, Coils A and B in parallel, C in series.
Clip 5, Coils A and B in parallel.
Clip 7, Coils A, B and C in parallel.

Several sets of efficiency tests were made with each combination. The three pairs of coils were then replaced by a single pair of coils connected in series, and having several terminals so that the number of turns used might be altered. This was used in connection with a Thomson-Houston rheostat. Efficiency tests were made with and without the rheostat. Only a few of the tests and curves obtained can be given in this paper. In comparing these curves among themselves and with the result of other experiments, it should be noticed that the voltage was considerably below that for which the motors were designed, and that the power delivered was measured at the car axle. Different armatures were used on different days, and the curves in different plates are not strictly comparable; but the curves given in any one plate were taken with the same armature and with approximately the same voltage. Each of these armatures had been recently repaired, and although they had been well baked there may have been some leakage through the green shellac. The Foucault currents in the cores were probably greater than in the new armatures. With the same armature and fields the efficiency is a few per cent. higher cold than when hot. It has been the aim to run as nearly as possible at the temperature of ordinary running, so that the fields were comfortably warm but not hot. It is confidently believed that the efficiency of these machines would be considerably above 90 per cent. if taken at armature shaft and with full voltage.

Fig. 1 shows efficiency curves for the motor, with different combinations of the field coils.

In Fig. 3, curves A and B show efficiency of the machine with 857 and 611 turns of No. 7 wire in the field coils. It will be noted in Figs 1 and 3 that the motor has highest efficiency with the larger number of turns on field coils until the iron is saturated, when the better efficiency is given with smaller number of turns and consequent lower resistance in field. This shows the advantage of working on the fifth and seventh clips with barrel regulator, or of cutting out part of the turns on field when the load is heavy. On starting the car the current is very heavy and the field is saturated with a small number of turns; hence the torque with a given current is nearly the same, whatever the windings of the field. The speed and counter E. M. F. are small at starting; hence the potential difference at the armature brushes should be reduced until it passes only enough current to start the car without jerking. The easiest way of reducing the potential difference at the brushes is by interposing resistance; and the heat developed by the $C^2 R$ can be cared for more easily and cheaply in an open rheostat than in the field coils. Rheostats of iron and mica are cheaper and more heat-proof than cotton covered wires. This forces the conclusion that for the heavy load due to accelerating the car at starting, the field should have the smaller number of turns, and as the car reaches normal speed, and the horse power and C become less, the efficiency of the motor would be raised by increasing the number of turns in the field. This conclusion is exactly the reverse of the common practice of manufacturers who sacrifice some efficiency for speed at small horse powers. It is also in line with the experience of the road mentioned, that replaced the commutated fields with a single series coil of No. 7 wire, and later with No. 5 wire. This heat loss could be saved and the average efficiency raised by using the two motors in series at the start, and afterward cutting out one or putting the two motors in parallel if necessary, as the speed increases and horse power decreases. An average of 12 tests on the road shows that with two motors on a car it requires 27 per cent. less current if only one is working.

In Fig. 2, curve A shows the efficiency of Sprague motor with single pair of coils when the whole of a Thomson-Houston rheostat is in circuit. B shows about three-fifths of the rheostat in use; and in C it is all out. The dotted line A^2 gives the efficiency as calculated from the difference of potential about the motor alone. Curve A_2 is not strictly comparable with the others on account of the necessary variations in the voltage at the motor; but it does show the increased efficiency to be obtained by utilizing the superfluous voltage in a second motor in series. In this connection it is interesting to note that the resistance of rheostat, as calculated from current and potential difference, decreases with increase of current. This is as expected, since the larger part of the resistance is due to surface contact between the plates of iron in the rheostat, these being pressed together more closely as the iron heats. A similar effect but much more marked has been noticed in earlier experiments by one of us, with alternate plates of carbon and iron.

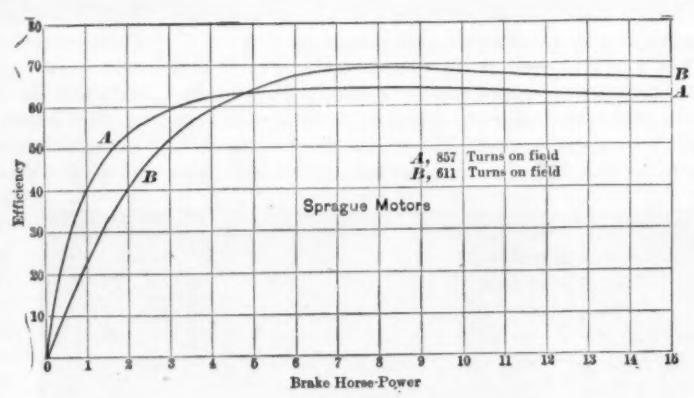


Fig. 3.

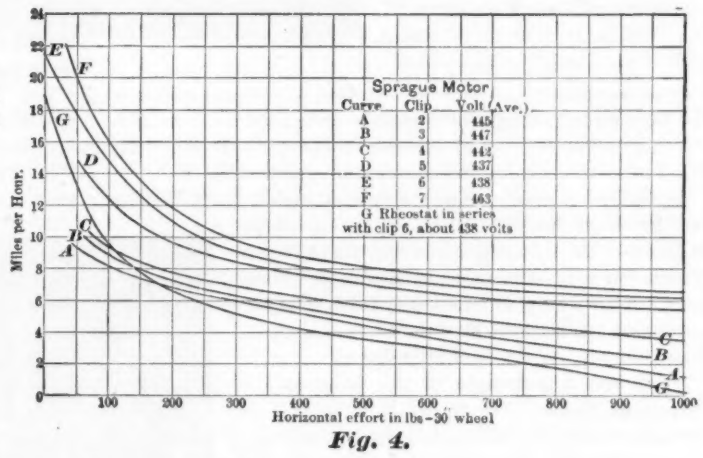


Fig. 4.

SOME CURVES OF RAILWAY MOTOR TESTS.

Figs. 4, 5 and 6 show curves of torque, speed and horse power, referring to the No. 6 Sprague motor. In Fig. 5, A shows horse power and horizontal effort on a 30-inch wheel; B, C, D, E and F clips 2, 3, 4, 5 and 7, respectively. In Fig. 6, A shows speed and horse power, with all of the rheostat in; E with $\frac{2}{3}$ of rheostat in; B, C, D, F and G clips 2, 3, 4, 5 and 7, respectively. These may be compared with results presented by Prof. S. H. Short before the Chicago Electric Club, March 28, 1892. Fig. 7 gives curves of current, torque, speed and efficiency from a 15-h. p. Thomson-Houston single reduction motor. The reduction ratio is 4.7857.

A large number of running tests were made on cars in regular service. Fig. 8 shows a run on the interurban line between Minneapolis and St. Paul. The distance is about 10 miles, the schedule time 55 minutes, cars equipped with two 25-h. p. single-reduction motors. Special trains sometimes make this trip in 30 minutes or less. Fig. 9 shows

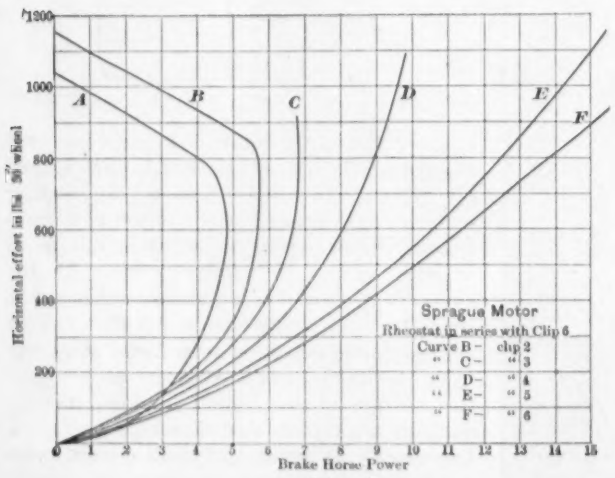


Fig. 5.

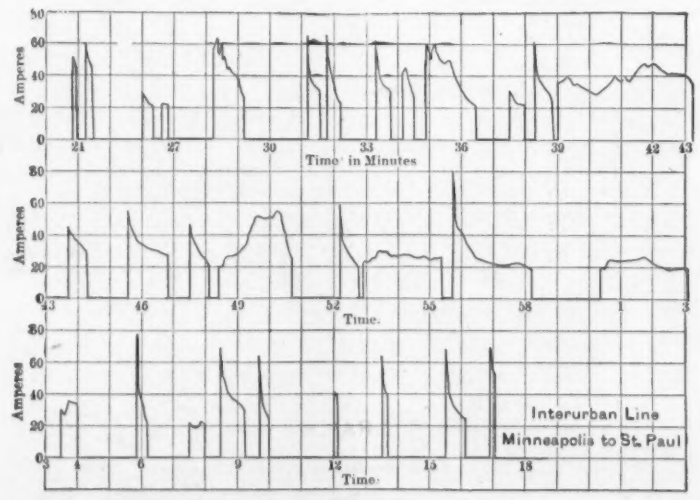


Fig. 8.

SOME CURVES OF RAILWAY MOTOR TESTS.

*A paper read before the American Institute of Electrical Engineers.

three runs on the University line of Minneapolis on successive days, with the same car and same driver. The lower curve was taken when the rails were dry and dusty, middle curve with wet rails, and upper curve when the ground was covered with snow, eight inches deep on the level. The snow-plow had been over a part of the track about an hour before. The curves show variation of time, number of passengers being noted.

	Feb. 5.	Feb. 6.	Feb. 7.
Condition of track	Dry.	Wet.	Snowy.
Number of stops	38	50	36
Average voltage	445	450	440
Average ampères	15.15	14.9	17.5
Average ampères while working	23.4	20.9	28.1

It will be noted that the current was less with wet rails, although there were more passengers. The load at the station is about the same for a rainy day as for a dry, the difference being probably made up by the increased leakage on the lines and by the larger number of passengers on some cars.

Fig. 9 shows variation of current on a single car. Fig. 10 shows variation of current on a feeder to line with five cars, the average current being about 60 ampères. Fig. 10 is plotted from readings taken at intervals of two seconds. The ammeter stops some little time at the high and low points, showing that these are actual values of the current and not due to the inertia of the ammeter.

Fig. 11 gives the results of readings one second apart taken on the main ammeters in Minneapolis and St. Paul, and on one feeder in Minneapolis. There were about 190 cars on the Minneapolis line, 100 on St. Paul lines and 32 on the one feeder.

Fig. 12 gives the daily load of the Minneapolis power house, the curves being plotted from readings of the ammeters taken at 10 minute intervals throughout the day. In this case the power units are unusually large, there being two triple expansion condensing Corliss engines, the constant loss from friction in engines, shafting and dynamos averaging 218 h. p. Indicator cards were taken simultaneously by means of electromagnetic attachments on each of the 12 indicators, the same current also giving signals to the observers at the ammeters.

A series of 13 tests were made for ascertaining the effect of wetting or greasing the rails on a curve. Two cars were coupled by a spring dynamometer and the pull noted while rounding the curve at ordinary speed, which was kept nearly uniform by means of a brake on the motor car. The average pull on the dynamometer is as follows:

	Dry.	Wet.	Greased.
Outer track	500-800 lbs.	400 lbs.	300 lbs.
Inner track	650 "	400 "	400 "

The inner rail was wet or greased in each case; but on the inner track the greasing was not so thorough on account of the lateness of the hour. It is noticed that wetting the rail reduces the power required about one-third, and greasing reduces it one-half. Readings of the ammeters on the car correspond in general with the dynamometer readings.

The "bucking" of street car motors is a subject of considerable interest to street railroad men, although it seems never to have been discussed in public. From the silence of the books and papers, and from the ideas current among railroad employés, the conclusion is reached that little is known about its conditions, causes or remedy. It is therefore thought wise to present the results of observation and tests, with a theory for the cause and remedy. It sometimes happens that an electric car suddenly stops as if by collision. In some cases the car refuses to go further, but usually it goes ahead immediately as if nothing had happened. This is known among railroad men as "bucking." To explain the action it is noted that in common practice the motor fields are connected between the armature and trolley, the armature being grounded at the negative brush. If a second ground occurs on any part of the machine except between the fields and trolley, a heavy current passes to ground, giving an intensely strong field while the armature is short-circuited by reason of the two ground connections. It therefore acts as a dynamo on short circuit, and becomes a powerful electric brake that stops the car very suddenly. This agrees with the facts, since a second ground, either from loose connecting wires or broken insulation, always causes bucking. Evidently if the ground occurs entirely outside of the machine no bucking follows, since the series motor cannot excite its own fields and act as a dynamo unless the armature connections are reversed. It is common practice to connect the two motors together between the fields and armature to equalize the work of the two machines. When a ground occurs in such a case both armatures act as brakes and the bucking is more violent than when the "equalizer" connection is not used. A loose reversing switch has been known to reverse the motors accidentally and spasmodically. There are many cases of bucking where no evidence of a second ground can be found. Doubtless some of these may be accounted for by a temporary ground which burns itself out—a common method of removing grounds and crosses. This explanation will not hold in many cases. Extended inquiry was, therefore, made among railroad men in order to gather as many facts as possible. Some of these reports were incredible at first, but seem to be honest testimony, and were afterward corroborated by others.

It may be well to state that the term "bucking" is used with some looseness, being sometimes applied to cases where a motor acts badly for a variety of reasons, but as used in this article it is to be taken in the sense above noted. There is a tradition among the car drivers that a motor is very liable to buck if the current is full on while running down hill, but no case of this sort could be substantiated. Cases are reported of motor bucking when the circuit is opened for an instant, as may be caused by the trolley jumping off and on, or by the car pasing over a dead rail or over a very dirty track. It is not plain that this is a true case of bucking, but rather of a sudden cessation and reapplication of the propelling force.

Sometimes a car will buck at regular intervals. Examination of the motor shows a small bright spot on one brush which rolls to and fro at the contact between brush and commutator. This is intensely bright like a ball of melted metal and grows larger until nearly three-fourths of an inch in diameter, when it suddenly explodes with considerable noise and a blinding flash, and at the same instant the motor "bucks." The car goes on again at once, and the cycle is repeated again in the time required to run from one-half to four city blocks at ordinary speed. In such a case the bucking is stopped by shifting the brushes.

One case is reported where a motor bucked hard although the brushes were removed so that the armature was entirely disconnected. Here the field was charged by being in parallel with the field of the other motor, and a cross in the armature coils short-circuited it. The foreman of the repair shop where our efficiency tests were made states that on six or eight occasions he has seen a motor buck because the carbons were not properly placed in the holders. In testing armatures rapidly the carbons are sometimes placed carelessly so that the presser-foot rests partly on the carbon and partly on the holder. This presses the carbons against the commutator so as to give good contact until the carbon wears off a little, when the presser-foot no longer feeds it in. Vigorous flashing occurs, culminating in a buck, the shock of which may jar the presser-foot into its proper position, when the motor runs on as if nothing had happened, leaving behind no trace to indicate the cause of trouble.

Cases have been reported where a wire on the track touched the motor as it passed, thereby grounding it and causing it to buck. Similar grounding may be caused by water or mud being thrown upon certain parts of the motor.

The motors with Gramme ring armatures are known to buck more frequently than those with drum armatures. These buck worse when run on the "loop," *i. e.*, with part

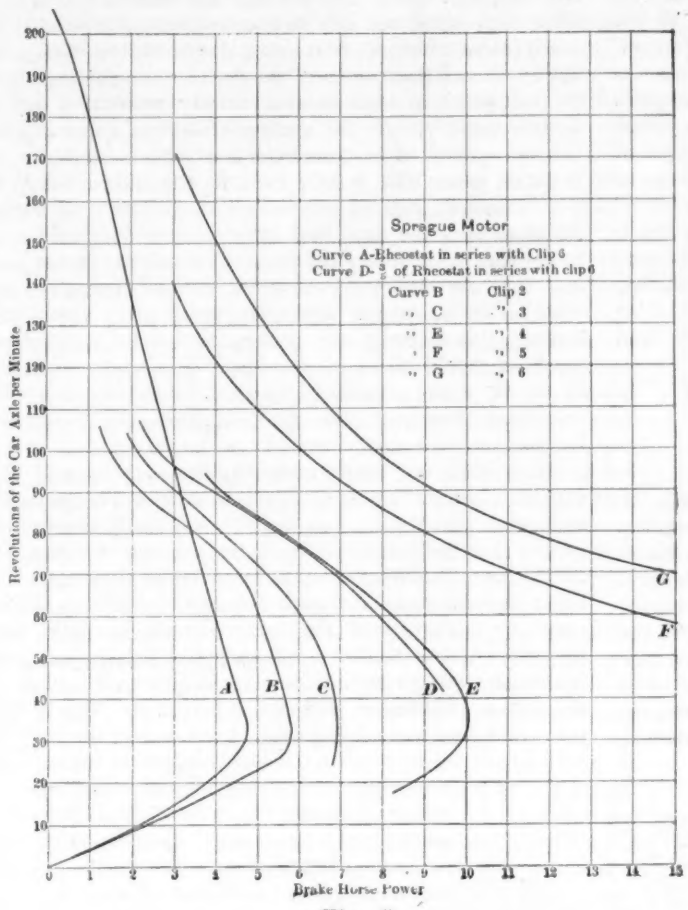


Fig. 6.

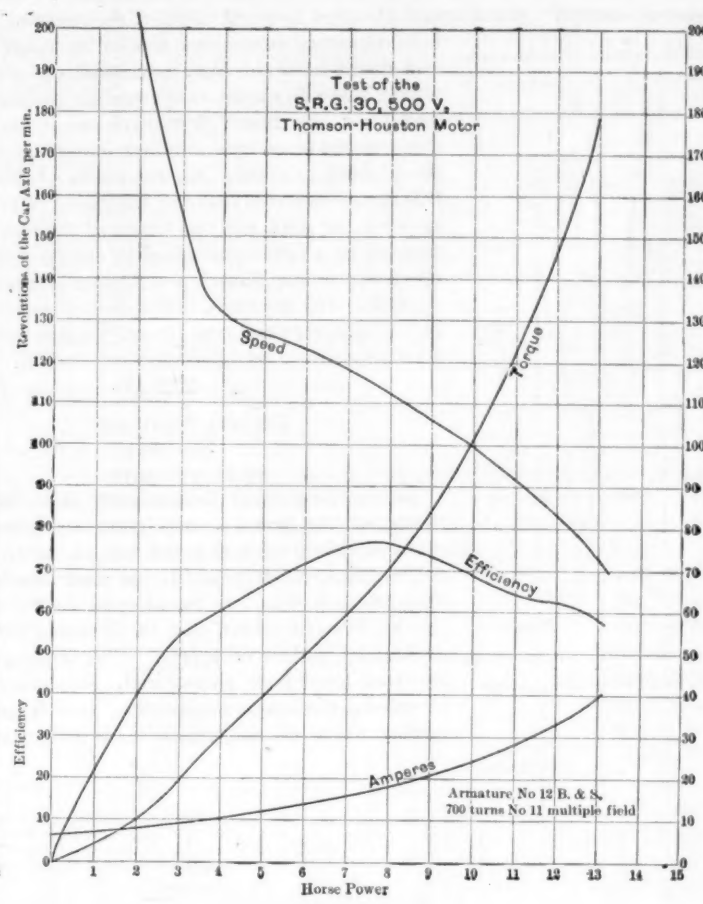


Fig. 7.

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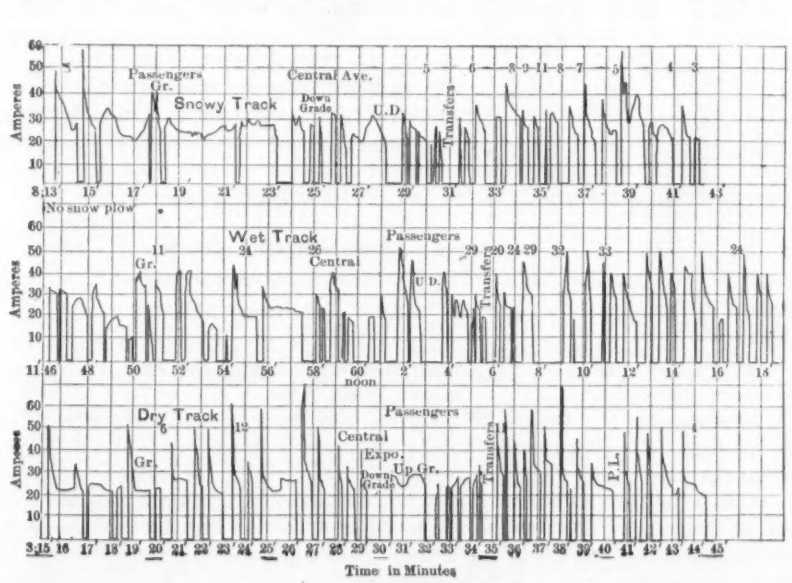


Fig. 9.

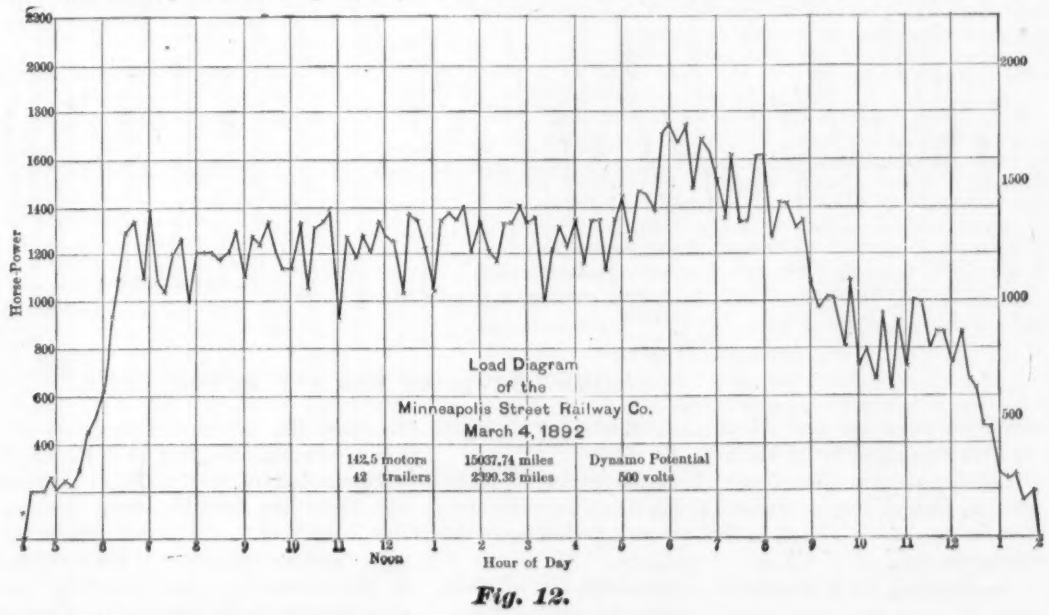


Fig. 12.

SOME CURVES OF RAILWAY MOTOR TESTS.

of the field coils cut out, some of them bucking regularly every time the loop is cut out. This is one reason why the use of the loop has been abandoned on this road except in a few cases. The machines with commutated fields would buck when the field coils became old, although they showed no signs of being grounded. Bucking became much less frequent when the commutated fields were replaced by a single pair of series coils.

It was noticed that bucking was very commonly preceded by flashing at the brushes, although flashing was not always followed by bucking.

The explanations offered are various. One is that the iron in the fields varies in magnetic quality, so that one motor works harder, and by some means acts upon the other as a dynamo. Another is that one motor becomes reversed

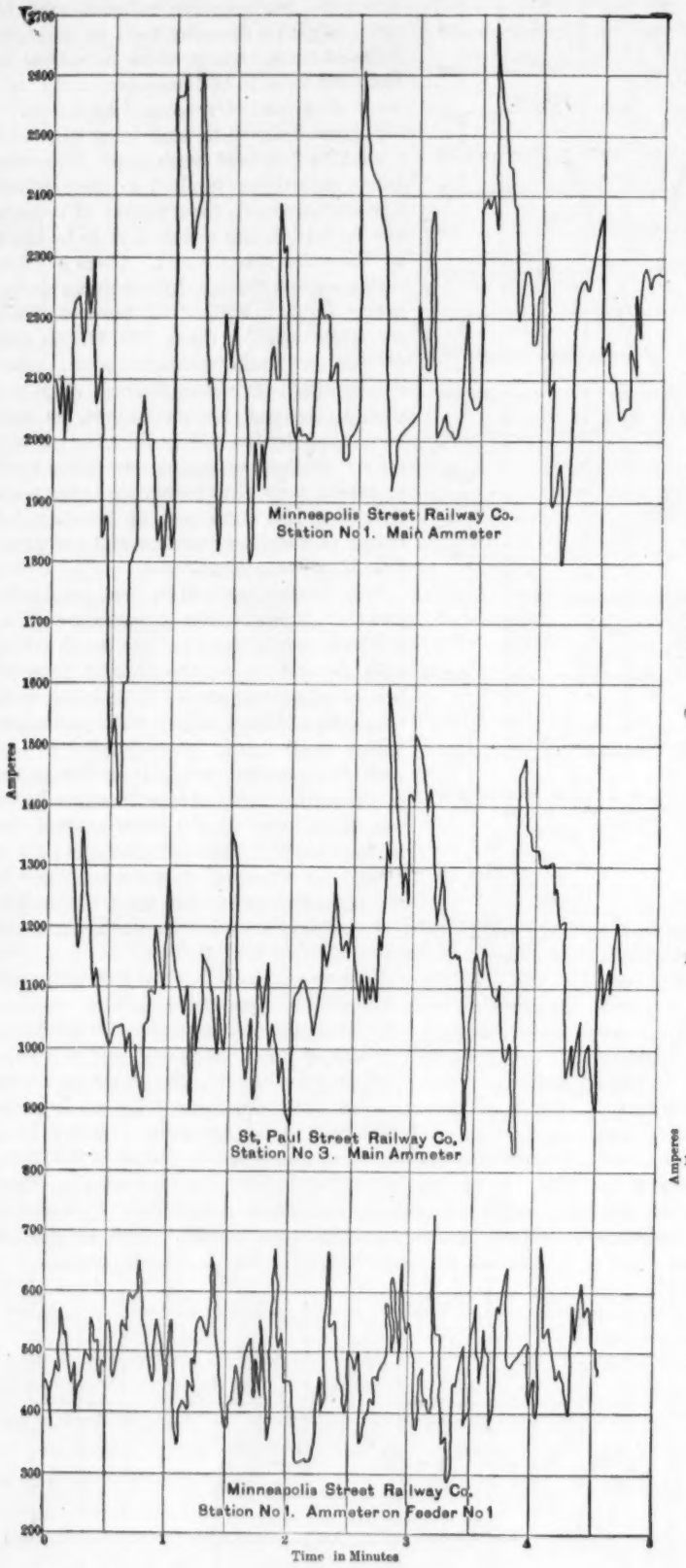

Minneapolis Street Railway Co.
Station No 1. Main Ammeter
St. Paul Street Railway Co.
Station No 3. Main Ammeter
Minneapolis Street Railway Co.
Station No 1. Ammeter on Feeder No 1
Amperes
Time in Minutes

Fig. 11.

SOME CURVES OF RAILWAY MOTOR TESTS.

while the other does not. Another is that bucking is caused by poor brushes or brush holders.

One explanation offered was that a partial break in the circuit, such as may be caused by shaking a loose connection, induces a high E. M. F. that causes a flash to span the commutator.

In searching for a reasonable explanation for all these cases in which no second ground connection existed, it was noticed in each case that bucking was more liable to occur when the field was comparatively weak; also where the armature reaction was greater. In each case the neutral line is shifted and the coils under the brushes are in an active field. The large current in short-circuited coils further distorts the field, and the sparking at the brushes becomes excessive, causing a vigorous flashing. As soon as the counter E. M. F. in the sections leaving the brushes rises above 20 volts, the arc is carried around from one brush to the other, thus grounding the positive brush and short-circuiting the armature, which then acts as a dynamo and causes the motor to buck. Such bucking is usually less vigorous than when caused by a dead ground, on account of the resistance of the arc. This explanation covers all the cases noted.

Such being the causes of bucking the remedies are plain. Armature reaction must be reduced. This militates against the conclusion drawn by Mr. Parshall in his recent Institute paper, that the strength of field is of little importance, and that the windings of the armature should be a maximum. The liability to bucking would be reduced even when there is a large armature reaction, if the armature is divided into a large number of sections.

An obvious remedy for bucking caused by direct grounding would be to connect the fields between armature and ground instead of between armature and trolley. With such an arrangement, a ground on the fields would simply cut out a part of the coils, and cause that machine to work harder. A ground at brush between armature and field would cause a sudden forward impulse on account of the field requiring some time to lose its magnetism, and would blow the fuse. A ground on armature would likewise cause a sudden forward impulse and blow the fuse. With such an arrangement there would be no true bucking except in case of the flashing as noted. An incidental advantage of this arrangement is that the difference of potential between the field and the frame of the machine is reduced to a few volts caused by the drop through the field; hence there is less danger of grounding the field. The increased difference of potential between armature and core is only a few volts, and would not affect the insulation very much.

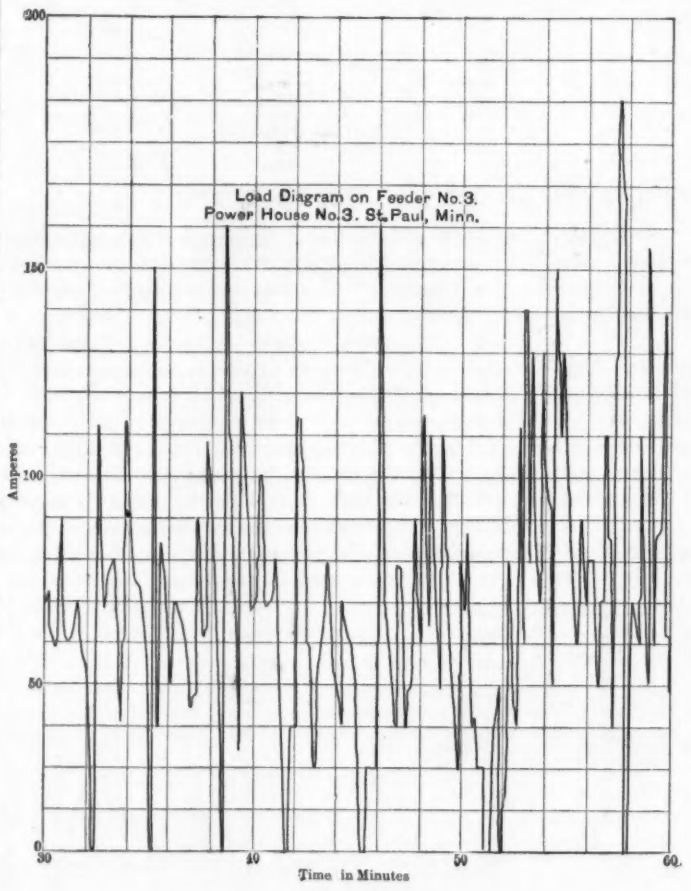


Fig. 10.

Central Stations.*

BY D. THOMSON.

The building should be one story high, built directly on the ground, with good and substantial walls of either brick or stone, set on well footed foundations, with peaked roof and fan-lighted ventilators or windows running its entire length, the windows of which can be operated from the ground by means of levers. The material for the roof should be corrugated, galvanized iron fastened to the beams and purlins, which are preferably made of angle iron, care being taken to see that the corrugated iron has some good fireproof, non-conducting lagging laid under it to prevent the condensation of the moisture contained in the warm air inside the building from coming in contact with the cold roof. A proper tower should be provided at one end, or the centre of the building, for the entrance of the necessary wires; markedly in contrast to the old plan of utilizing the wood work on top of any window or door that might be the handiest to honeycomb with holes for that purpose. Proper stone and cement foundations should be provided for engines, shafting and dynamos, which must not have any connection with either the walls or the foundations of the building; the floor to be preferably of concrete with a rock asphalt top of at least three-fourths of an inch in thickness, except where there are pipes and pits that cannot be well covered with other material than wood, on account of the necessity of being able to get at them at any time; such wood floor should be at least two inches in thickness, of good red pine well seasoned, laid on good strong joists and beams, the beams being supported on brick or stone and cement piers suitably placed.

In the matter of engines, there can be no doubt that in stations of any considerable size (say from 100 h. p. up) the most suitable for the purpose are what is known as cross connected twin engines of slow speed, and where water is available for condensing purposes they are preferably built with high pressure cylinder on one side and low pressure condensing on the other, though where the boilers are such that very high pressure can be carried (150 pounds or more) it is a question whether results just as beneficial cannot be obtained by using a third cylinder, and a consequent triple expansion of the steam admitted at the first cylinder at such high pressure. There cannot be any doubt whatever that such engines can be operated at considerable saving over the best of high speed engines that are manufactured, and these high speed can only be recommended for isolated or small plants where slow running single engines would be apt to cause a fluctuation in the lights when passing their centres, which in high speed is entirely eradicated owing to their velocity. In the matter of boilers, there can be but one opinion where tests have been made, and that is in favor of water tube boiler, such as the Babcock & Wilcox, Crandell, Zell, or some other modification of them, for aside from the fact that they possess an element of safety that the ordinary return tubular boilers do not possess, they are quick and economical steamers and cost very little for maintenance. After the steam plant comes the belting, line shafting and pulleys, which for satisfactory working should all be of the best. The shafting should be fitted with self-oiling bearings, with oil reservoirs and ring feeders; said shafting and the necessary hangers or standards should be constructed in such a way and of such material that they will be capable of standing a strain equal to at least 100 per cent. more than that which they will be ordinarily required to carry. The pulleys should be of the grip or clutch type built so as to be able to carry at least double their ordinary load; the pulleys to be of such a design that if it should be necessary to stop one of the dynamos, both the pulley and the grip will stop together, and only the driving mechanism continue to revolve, thereby enabling the setting up of the grips or clutches on any one if required. This is the point that designers of central stations would do well to bear in mind. It has occurred in the writer's experience that where grip or clutch pulleys whose grips revolved with the shafting were used it became necessary to stop an entire line of shafting together with the engine, to adjust one slipping clutch out of some four or five on the same line shaft, the pulley in that case being an elegant one in every particular but in this one point, that the clutch could not be stopped with the pulley.

Now to conclude, have your station fitted out with the best of dynamos and generators, and don't buy such apparatus simply because the price is low; in fact cheap machinery is generally the dearest in the end. Let your switchboards be models of completeness, and have them kept so continually. Bear in mind that they are your distribution points, and that if they fail you, your entire plant will be jeopardized. Have your lines and circuits equipped with good and efficient lightning arresters, so that danger from this source will be a nullity. Make this part of your plant such that it can easily be got at, and if an arc should be caused through any means, have the necessary appliances at hand to break it as quickly ae possible; one of the best things for such purpose is a bucket full of dry sand.

* Abstract of a paper read at the first annual meeting of the Canadian Electrical Association.

Long Distance Telephony.—I.*

BY HUGH NEILSON.

The subject of my paper naturally divides itself into three heads—the lines, the equipment and the rates.

Lines.—When wires were first erected for the purpose of communicating by telephone between points at a distance, it was quite natural that, as many of the officers connected with the business had formerly been telegraphers, the construction should be the same as they had been in the habit of using, and accordingly No. 9—and in some places No. 12—iron wire was used, strung on poles of the usual length, 25 or 30 feet, and on ordinary glass insulators, or sometimes without insulators, the reason for the latter being that it was supposed that where two or more wires were strung the leakage to the ground would prevent a certain amount of cross talk. It is needless to say this expectation was not realized, and that first-class insulation is now considered as essential as on telegraph lines. Many miles of such lines were erected in the States before 1885. In the Dominion, the Bell Telephone Company of Canada was early in the field, and in October, 1881, a line of No. 12 iron wire was put up between Hamilton and Toronto. It was soon seen, however, that iron wires, even of a good size, were not satisfactory over distances of 100 miles; and even with copper, induction was very apparent,

* A paper read at the first annual meeting of the Canadian Electrical Association.

and made conversation difficult when more than that distance was attempted. It was then seen that only by metallic circuits and the use of copper wire was it possible to do thoroughly first-class and satisfactory work over long distances.

In 1885 the American Telephone and Telegraph Company constracted a line between New York and Philadelphia carrying 26 wires, or 13 metallic circuits. As soon as an attempt was made to use these lines it became apparent that the difficulty of working, on account of induction between the metallic circuits, was as great as with single wires. A large number of experiments showed that only by a most complete system of transposition, so that every metallic circuit should maintain the same relative exposure to every other circuit, was it possible to overcome this difficulty. This involves much more work than would naturally be supposed, but it is absolutely necessary for efficient working. The success of this New York and Philadelphia line was such that the company commenced the construction of a line from New York to Boston, carrying 80 wires. This also works perfectly, as I can testify from personal use. Extensions to Albany, Saratoga, Syracuse, Rochester and Buffalo followed, and at this date thousands of miles of poles and many thousand miles of wire are in use, the property of the above mentioned company.

The poles used in building these lines are of the best material procurable. Cross-arms are of pine securely fastened by lag screws and braced with iron braces so that each arm is as rigid as the pole itself. The poles are put into holes much deeper than usual, they are tamped more carefully, and in soft ground cement, sand and broken stone, make an artificial foundation. The poles are, of course, closer together than is usual in telegraph construction, and on curves the distance is again shortened. It is simply impossible, looking at it from a reasonable point of view, to build pole lines in a more perfect manner than the lines of the long distance company.

The wire is No. 12 B. & S. G. (.104 inch diameter) of hard drawn copper, with a resistance of 5.2 ohms per mile. All joints are made with the McIntyre sleeves, which seem to give as good a connection as any soldered joints, without endangering the strength of the wire by heating. Where many wires are required, 10 are strung at a time, the ends of the wires being drawn from the drums by a team of horses. A long bar to which all the wires are fastened is drawn along by the horses, and at each pole a lineman is stationed to lift the wires to the proper place. I need not say that in Canada we do not string 10 wires at a time, but if we should ever find it necessary to do so we have the experience of our friends in the States to guide us.

While the mechanical work on these lines is so perfect, great care is also taken that when erected everything shall remain in the finest order at all times. The route for the line is selected with a view to as little interruption as possible from such disturbing elements as trees. Contracts are entered into for trimming, or in some cases removing them altogether. Poles are not put near gateways or near other poles. Long poles are used where the ground is low, and short ones when placed on knolls. In fact it is almost impossible to mention anything of advantage in the construction of a line of poles that has not been adopted by the Long Distance Company.

In Canada we have tried to do as good work as in the States, always keeping in view the fact that we cannot hope to get as good rates, and therefore construction expenses must not exceed a reasonable amount. The new lines now in course of construction have forty poles. The wire is No. 13 hard drawn copper; McIntyre joints have always been used, and transposing is carried out thoroughly. In future no pole less than 35 feet in length will be put up, except on unimportant routes not likely to ever carry more than a few wires.

Operating Telephone Companies.*

BY ALLEN R. FOOTE.

The report on telephones for the Tenth Census (1880) is presented in volume IV., commencing on page 787. Preceding the tables the following statement is made under the heading of "Remarks:"

It is of the first importance to remember that the census year 1879-1880 was the year in which the telephone business passed through the stages of an unprecedented development. At the beginning of that year this business amounted to little or nothing. At the end of the year it represented one of the greatest interests of the country. Neither the census nor any other statistical agency can deal in a wholly satisfactory manner with anything which is subject to rapid and violent changes.

The tables exhibit 148 companies and private concerns, which aggregate 34,305 miles of wire, 54,319 receiving telephones, and 3,338 employés.

The collection of these statistics has been with a view to exhibit the telephone business in 1880 as completely as circumstances allowed, and for the purpose of establishing a basis for the future taking of such statistics.

The inquiry into this subject for the Eleventh Census is assigned to the Division of Manufactures to place it properly in the group of electrical industries in said division. The form of publication adopted for the Tenth Census disclosed the detailed statistics for each reporting company. The form of publication adopted for the Eleventh Census is particularly designed to avoid disclosing the individual statistics of any reporting company, firm or person. For this reason, in presenting the statistics of operating telephone companies, a consolidated report is given, in which is grouped the statistics of all reporting companies, and comparison made with corresponding statistics for the year 1880, so far as the same are exhibited in the Tenth Census report.

*From Census Bulletin No. 196.

TABLE I.—COMPARATIVE STATEMENT, 1880-1890, OF OPERATING TELEPHONE COMPANIES' INVESTMENTS, REVENUES AND EXPENSES.

ITEMS.	1880.	1890.	Increase. Amount.	Increase. Per cent.	Decrease. Number or amount.	Decrease. Per cent.
Number of companies, firms and reporting persons...	148	53	.....	.....	95	64.19
Investments:						
Share investments	13,358,720	67,349,171	53,990,451	404 16	.....	.....
Bond "	1,247,067	4,992,565	3,745,498	300.34	.....	.....
Total interest-bearing and profit-sharing investments	14,605,787	72,341,736	57,735,948	395.30	.....	.....
Investment per mile of wire	426	301	.....	.....	$125.00	29.34
" subscriber	302	318	16	5.30	.....	.....
Revenues and expenses:						
Gross earnings	3,098,081	16,404,583	13,306,502	429.51	.....	.....
Gross expenses	2,373,703	11,143,871	8,770,168	369 47	.....	.....
Net earnings	724 378	5,260.712	4,536,334	626.24	.....	.....
Aggregate dividends	302,730	3,168,208	2,865,478	946.55	.....	.....
Surplus	421,648	2,092,504	1,670,856	396.27	.....	.....
Per cent. of net earnings on total investment	4.96	7.27	2.31	46.57	.....	.....
Per cent. of aggregate dividends on share investments	2.27	4.70	2.43	107.05	.....	.....
Gross earnings per mile of wire	90.31	68 24	.....	.....	$22.07	24.44
Gross expense " "	69.19	46.36	.....	.....	22.83	33.00
Net earnings " "	21.12	21.88	.76	3.60	.....	.....
Aggregate dividends per mile of wire	8.83	13.18	4.35	49.26	.....	.....
Surplus per mile of wire	12.29	8.70	.....	.....	3.59	29.21
Gross earnings per subscriber	63.99	72.15	8.16	12.75	.....	.....
Gross expense " "	49.03	49.01	.....	.....	.02	0.04
Net earnings " "	14.96	23.04	8.18	54.68	.....	.....
Aggregate dividends per subscriber	6.25	13.94	7.69	123.04	.....	.....
Surplus per subscriber	8.71	9.20	0.49	5.63	.....	.....

Examination of the report now presented will show that many items are reported for the Eleventh Census that do not occur in the report for 1880, thus broadening the basis of comparison for future reports.

TABLE III.—COMPARATIVE STATEMENT, 1880-1890, OF USE MADE OF OPERATING TELEPHONE FACILITIES.

Use made of facilities.	1880	1890	Increase. Number.	Increase. Per cent.
Exchange and toll stations	.....	203,060	.....	.....
Extra exchange toll stations	.....	1,037	.....	.....
Private lines and other stations	.....	23,260	.....	.....
Total number of subscribers	48,414	227,357	178,943	369.61
No. of subscribers per exchange	111	183	72	64.86
No. of exchange conversations	.....	450,000,000	.....	.....
No of extra-territorial conversations	.....	3,200,000	.....	.....
Total No. of conversations	.....	453,200,000	.....	.....
Average daily calls per subscriber:				
Exchanges with 100 or less subs.	.....	4.80	.....	.....
Exchanges with 100 to 200 subs.	.....	6.25	.....	.....
Exchanges with 200 to 500 subs.	.....	7.43	.....	.....
Exchanges with 500 to 1,000 subs.	.....	8.00	.....	.....
Exchanges with 1,000 to 1,500 subs.	.....	8.67	.....	.....
Exchanges with 1,500 subs. and over	.....	8.86	.....	.....
Average price paid per sub. per call:				
Exchanges with 100 or less subs.	.....	3.25 cents.	.....	.....
Exchanges with 100 to 200 subs.	.....	2.33 "	.....	.....
Exchanges with 200 to 500 subs.	.....	2.40 "	.....	.....
Exchanges with 500 to 1,000 subs.	.....	2.37 "	.....	.....
Exchanges with 1,000 to 1,500 subs.	.....	2.14 "	.....	.....
Exchanges with 1,500 subs. and over	.....	3.50 "	.....	.....

The percentages of increase and decrease from 1880 to 1890, in those items of essential interest to the public, are shown in the following summary:

SUMMARY SHOWING PERCENTAGES OF INCREASE OR DECREASE FROM 1880 TO 1890.

Items.	Increase. (Per cent.)	Decrease. (Per cent.)
Number of companies, firms and persons reporting	.....	64.19
Interest-bearing and profit sharing investment	395.30	.....
Interest-bearing and profit-sharing investment per mile of wire	.....	29.34
Interest-bearing and profit-sharing investment per subscriber	5.30	.....
Net earnings per mile of wire	3 60	.....
Net earnings per subscriber	54.68	.....
Number of exchanges	183.98	.....
Miles of wire per exchange	145.57	.....
Number of subscribers per exchange	64.86	.....
Number of employés per exchange	.....	12.50
Miles of wire	600.81	.....
Miles of wire per subscriber	49.30	.....
Number of subscribers	369 61	.....
Number of employés	158.99	.....

The above summary shows that the number of ubscribers has increased during the decade 369.61 per cent., the number of persons brought into communication per exchange has increased 64.86 per cent., the mileage of wire per subscriber has increased 49.30 per cent.; while the interest-bearing and profit-sharing investment has increased but 5.30 per cent. per subscriber.

Unfortunately, the census report for 1880 affords no basis of comparison for cost to subscribers per conversation. While these data possess considerable statistical value, it is impossible, by such methods, to convey a proper representation of the actual changes that have occurred in the business of operating telephone companies during the decade from 1880 to 1890. Improvements in instruments and exchange switchboards, changing from grounded to metallic circuits, placing wires underground, extension of lines to extra-territorial districts, and, finally, the introduction of long distance service combined to make the service rendered in 1890 more valuable and satisfactory to subscribers than the service rendered in 1880.

The presence in the statistics for 1890, for the first time, of the items "5,029,438 feet of cables" and "54,690 miles of wires underground," requires a few words of explanation and comment. The rapidly increasing number of subscribers rendered it imperative to employ a very large number of wires for the service. This led to the bunching of wires in cables. The average number of wires so bunched in present practice is about 50 pairs. The increasing number of wires and cables for various electrical purposes led to an urgent demand that the wires be placed underground in the congested districts of large cities.

A comparison of the cost of the two systems will be found in the subjoined table:

COST OF TELEPHONE LINE CONSTRUCTION.

	Per mile of wire.	Per mile of productive wire (a).
Aerial lines, individual wires	$35.00	$35.00
Aerial lines, cabled wires	(b)89.76	179 52
Underground lines, cabled wires.	(c)121.44	242.88

(a) The cost per mile of productive wire is calculated on the basis of existing conditions as follows: In aerial lines of individual wires all wires placed are productive. In aerial lines of cabled wires the productive wires average one-half of all wires placed. In underground construction the productive ducts and wires average one-half of all ducts and wires placed. In the cities of Washington, D. C., and Baltimore, Md., there are 6,061 miles of wire underground. Of these wires 2,980 miles are productive and 3,081 are non-productive at the present time (1892).

(b) At this rate per mile of wire the 5,029,438 feet of cables reported in 1890, containing 50 wires to the cable, cost $4,275,022 placed.

(c) At this rate the 54,690 miles of underground wires reported in 1890 cost $6,641,553 placed. The feet of cable and mileage of wire underground is a duplication to the extent in which cables are placed underground.

The report for 1880 included the statistics of the American Bell Telephone Company, as at that time this company operated one exchange. The report for 1890 excludes the statistics of the American Bell Telephone Company, since it is not now an operating company.

The following tables show the number of operating telephone companies, the amount and character of investments

TABLE II.—COMPARATIVE STATEMENT, 1880-1890, OF OPERATING TELEPHONE COMPANIES' FACILITIES FURNISHED FOR PUBLIC AND PRIVATE USE.

FACILITIES FURNISHED FOR PUBLIC AND PRIVATE USE.	1880.	1890.	Increase. Number.	Increase. Per cent.	Decrease. Number.	Decrease. Per cent.
Number of central exchanges	.....	774	.....	.....	.....	.....
Number of branch exchanges	.....	467	.....	.....	.....	.....
Total number of exchanges	437	1,241	804	183.98	.....	.....
Number of employés per exchange	8	7	.....	.....	1	12.50
Number of telephones and transmitters (*)	108,638	467,356	358,718	330.20	.....	.....
Length of cables in feet	.....	5,029,438	.....	.....	.....	.....
Miles of extraterritorial wire	.....	50,921	.....	.....	.....	.....
Miles of long distance wire	.....	40,309	.....	.....	.....	.....
Total mileage of extraterritorial and long distance wires	.....	91,230	.....	.....	.....	.....
Miles of wire on poles	.....	171,498	.....	.....	.....	.....
Miles of wire on buildings	.....	13,445	.....	.....	.....	.....
Miles of wire underground	.....	54,690	.....	.....	.....	.....
Miles of wire submarine	.....	779	.....	.....	.....	.....
Total miles of wire	34,305	240,412	206,107	600.81	.....	.....
Miles of wire per subscriber	0.71	1.06	0.35	49.30	.....	.....
Miles of wire per exchange	79	194	115	145.57	.....	.....
Number of day operators	.....	3,761	.....	.....	.....	.....
Number of night operators	.....	1,008	.....	.....	.....	.....
Number of other employés	.....	2,876	.....	.....	.....	.....
Total number of employés	3,338	8,645	5,307	158.99	.....	.....

(*) The report of 1880 gives "Number of receiving telephones in use, 54,319." To make comparison with 1890, a transmitter is added for each telephone.

revenues and expenses, the facilities furnished for public and private use, as well as the use made by the general public of such facilities for 1890 in comparison with similar data for 1880, so far as the same is possible considering the enlarged scope of the inquiry for 1890.

Table I. shows for 1880 and 1890 the number of operating telephone companies, the amount and character of investments, revenues and expenses.

Table II. shows for 1890 the facilities furnished for public and private use by operating telephone companies in comparison with similar data for 1880.

Table III. shows for 1890 the use made of the facilities furnished by operating telephone companies in comparison with the data obtained for 1880.

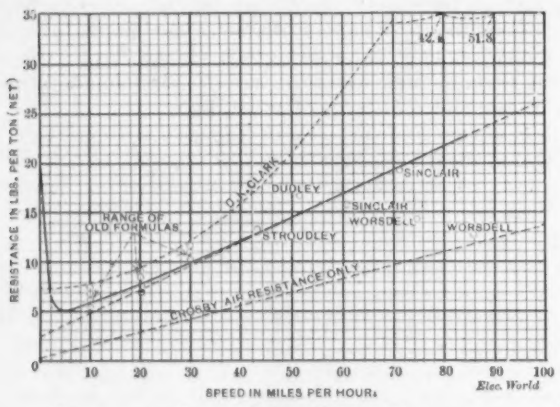
Supt. Parker in presenting the above report also adds the following interesting summary, exhibiting the aggregate increase or decrease in important items from 1880 to 1890 :

ITEMS.	1880.	1890.	Increase. (Amount and number).	Decrease. (Number.)
Number of companies, firms and persons reporting..	148	53	.....	95
Total investment	$14 605,787	$72 341,736	$57.735,949	.....
Gross earnings.	3,098,081	16,404,5-3	13,306,562	.....
Gross expenses.....	2,373.703	11.143,871	8,770,168	.....
Net earnings..	724,378	5,26 .712	4,536,334	.....
Number of exchanges	437	1,241	804	.....
Number of telephones and transmitters*..	108,638	467,356	358,718	.....
Miles of wire	34,305	240,412	206,107	.....
Number of employés.	3,338	8,654	5,307	.....
Number of subscribers.....	48,414	227,357	178,943	.....
Number of conversations.....	.....	453,200,000	.....	.....

*The report of 1880 gives "Number of receiving telephones in use, 54,319." To make comparison with 1890, a transmitter is added for each telephone.

High Speed Train Resistance.

In an interesting article published in a recent number of *Engineering News*, the editors give a very good summary of the data which exists on high speed train resistance, to which some new and valuable figures have lately been added, and draw some conclusions from the same, which will be found to be quite useful for electrical engineers interested in rapid transit roads. The authors of the paper plotted the values reported by various authorities, and deduce from those values what they consider to be a fair mean. After giving some of the data concerning the recent tests made by Mr. Sinclair, on the Empire State Ex-



CURVES OF HIGH SPEED TRAIN RESISTANCE.

press, of which we published a description in THE ELECTRICAL WORLD of June 18, p. 410, they make the following deductions, which we reprint here in full.

The total number of indicator diagrams given by Mr. Sinclair was 12, of which eight only are for even speeds, and the remaining four for gaining speeds. The last have an interest as showing how nearly the engine was doing its full work while gaining speed, and also for checking the probable accuracy of the diagrams at full speeds, but tell nothing as to mean rate of train resistance. Mr. Sinclair gives some computations of the average resistance in pounds per ton from these diagrams, but we have preferred to make independent computations for each diagram separately, and on a slightly different basis, giving fractionally different results.

The chief difference we made was to allow only five per cent. instead of 10 per cent. for the internal engine friction We do this for two reasons: First, because we do not believe it is ever so high as 10 per cent. in a well-built engine working up to its full power, and, secondly, because the extremely low train resistance shown in any case makes it improper to arbitrarily reduce it still more by an allowance for internal engine friction (not taxing adhesion), which may be too large. In Wellington's "Economic Theory of the Location of Railways" (p. 531) it is said: "The locomotive is a simple machine and the evidence does not make it probable that more than five per cent. to eight per cent. of its indicated power fails to reach the periphery of the drivers. Ten per cent. is often allowed." Several pages of facts and figures follow in support of this conclusion, and as locomotive practice is certainly not going backward, it is more probable now than when this was written that five per cent. is a sufficient allowance.

This being granted, we have for the train resistance, R, in pounds per ton (the speed in feet per minute being 88 times the speed in miles per hour:

$$R = \frac{(33{,}000 \times 0.95) H.\ P.}{88\ S \times W} = 356.25 \frac{H.\ P.}{S \times W}$$

in which W = the weight of the train in tons and S = the speed in miles per hour. Or, for a train weighing 270 tons this reduces to

$$R = 1.32 \frac{H.\ P.}{S}$$

Taking from the table in another column* the speed and horse power of each of the diagrams, we obtain by this formula the following table of resistances in pounds per ton :

TRAIN RESISTANCE RECORD, EMPIRE STATE EXPRESS TESTS.

Diag. No.	Speed m. p. h.	Total I. H. P.	Resistance in pounds per ton.	Attending conditions.
1.....	37.1	648.3	21.3	Getting up speed.
2.....	60.8	728.	15.8	Even spd., m. of 20.
3.....	44.	551.	16.5	Getting up speed.
4.....	58.	891.	20.2	" "
5.....	60.	990.	21.1	" "
6.....	69.	983.	18.8	Even speed.
7.....	70.5	977.	18.2	" "
8.....	68.6	972.	18.7	" "
9.....	69.6	1.045.	19.8	" "
10.....	70.5	1,059.	19.8	" "
11.....	78.9	1,120.	18 8	Descending grade.
12.....	71.9	1,056.	18.9	Even speed.
Mean, 6-12..	71.3	1,030.3	19.0	
No. 2	60.8	728.	15 8	
Stroudley...	43.3	....	13.2	

Now, let us rehearse a few more facts bearing upon this question, and then see if they give any common indications.

1. Mr. P. H. Dudley made some careful and extended tests of a (for that day) fast express on the New York Central & Hudson River Rail Road,† the train weighing 313 tons gross and 250 tons behind the tender, with the result that at 51.43 miles per hour (mean of some 20 miles) the total train resistance was 17.8 pounds per ton, which, less five per cent., gives 16.9 pounds per ton.

2. Mr. T. W. Worsdell, late locomotive superintendent of the Northeastern Railway, made some tests of his compound engines some two years ago with a train weighing some 695,000 pounds, or 347½ tons, including engine, taking some indicator cards at the unprecedented speeds of 75 and 86 miles per hour. Unfortunately, the Worsdell tests, so far as the indicator cards have been as yet made public, were directed chiefly or wholly to observing how the engine worked at various speeds, and not at all to determining how much work it had to do at any uniform speed. For the first purpose it is not important whether the train was gaining or losing speed at the moment the card was taken, for the last it is all-important. A series of seven cards at gradually increasing speeds from 5 to 80 miles per hour are alone given, and when the apparent train resistance is computed from these cards, as we do below,‡ it is evident at once that fluctuations of velocity materially modified most of them. At the lower speeds the train was apparently gaining velocity, and hence the apparent train resistances were higher than the real rate, while at the lower speeds the reverse was the case, and the real train resistance was greater than appeared. Comparison of the two high-speed resistances alone shows this. At 75 miles per hour the resistance shown is 14.2 pounds per ton, while at 86 miles per hour it is only 12.7 pounds.

Nevertheless, it is reasonable to suppose that there was an effort made to have these diagrams taken at a fairly uniform rate of speed, so that they should in a measure represent the normal demand upon the engine at that speed. A difference quite too small to be perceptible to the senses would make a considerable difference in the resistance shown, but it is probable that all slowing up which was perceptible to the senses was avoided, and if so, the error could not be so great but that the very low resistances obtained at such high speeds are entitled to much weight as cumulative evidence.

3. The range of the existing formulas for train resistance of any standing, for low speed resistances, is only about as follows :

For speeds of—	Resistance per ton.
10 miles per hour.....	5 to 7 lbs.
20 " "	6 to 9 lbs.
30 " "	10 to 12 lbs.

For these speeds the observations made have been so many that it may be accepted as tolerably certain that the truth lies somewhere within their range. The best known of these old and quasi-accepted formulas is that of Mr. D. K. Clark, which in its original form reads as follows for resistances in pounds per ton :

$$R = \frac{V^2}{171} + 8 \text{ for long}; = \frac{V^2}{181.5} + 7.16 \text{ for short tons.}$$

* See THE ELECTRICAL WORLD, June 18, p. 410, third column.

† Repl. Am. Ry. M. M. Assoc. 1882: Th. Loc. Rys., p. 519.

‡ The Worsdell tests were originally published and discussed, in their relation to train resistance, in the *Railroad Gazette* of March 28, 1890, but they were there wrongly discussed in that (1) the very considerable grade resistance, which was nearly half the total, was not deducted to determine the train resistance, so that the apparent train resistance was in some cases stated twice too large; (2) that no reference to nor allowance for the effect of variation in velocity was made The following is the complete record, corrected, from which it clearly appears that variations of speed had an important effect to reduce the apparent resistances at 75 and 86 miles per hour:

No.	Spd. m. per hour.	Cut-off, per cent. High pres.	Cut-off, per cent. Low pres.	Ind. h. p.	Grade per cent.	Trn. resist. lbs. per ton.
1	5	63	78	136	0.525 up	17.4 (26)
2	17	63	78	438	0.589 "	14.6 (25)
3	23	50	68	498	0.5 "	12.2 (21)
4	30	50	68	630	0.217 "	17.2 (20)
5	50	40	62½	662	0.363 "	6.3 (13)
6	75	47	67	1,041	level	14.2 (13½)
7	80	53	70	1,089	level	12.7 (12)

The figures in parentheses at the side of the last column above are the resistances as given by the *Railroad Gazette*, the engine friction having been taken at 10 per cent. instead of 5 per cent., as we do.

It is at once clear from the last column that if the first four resistances, for speed below 30 miles per hour, are correct, those for the higher speeds must be too low, *i. e.*, the train must have been in part propelled at the moment by its own stored energy and have been losing speed. Of Nos. 5 and 7 this is especially true, but it is also true of No. 6. Nos 1, 2 and 3, on the contrary, are all higher than the probable resistance, from which the inference is that the train was then gaining speed

The Worsdell engine used in these tests was a two-cylinder compound. It is said to have an average coal consumption of 25.4 pounds per mile, and to effect a net saving of 22 per cent. of coal.

These values are plotted on the accompanying diagram, but they are now generally admitted to be too high by one to two pounds per ton.

4. The element of axle friction only in train resistance is fairly well determined at about four pounds per ton for passenger and loaded freight cars, and six pounds per ton for empty freight cars at speeds of 10 to 30 miles per hour. The general law of friction is also well determined that at very high journal speeds the lubricants are so well carried around between the metallic surfaces that the friction is greatly reduced, and may also become evanescent. Mr. John W. Cloud and others have directly observed this fact in railway service, and expressed the opinion that at high speeds the journal friction proper may be less even than two pounds per ton.

5. Mr. O. T. Crosby,* late of the U. S. Corps of Engineers, recently made some experiments on air resistance of a novel type and at exceptionally high velocities, extending up to 130 miles per hour. He reached the conclusion (1) that air resistance at high speeds was very much less than current formulas made it, and (2) that it increased directly as the speed and not as the square of the speed. Without considering whether or not the last conclusion was warranted (we were not and are not prepared to admit it), the evidence when fairly considered was very strong indeed that air resistance at high speeds was much less than had been supposed.

Mr. Crosby's formula for air resistance in pounds per square foot of normal exposed surface was

$$R = 0.131\ V.$$

The normal exposed surface of a train, using the bounding rectangle rather than following the irregularities of the outline, as it is fair to do, is about $14 \times 10 = 140$ square feet, which is about one square foot for each two to three tons of weight of ordinary express trains. Allowing for the partially exposed areas along the side of the train, it might possibly be true that there was the equivalent of a square foot of exposed surface for each ton of weight, in which case the above formula would hold good also for the air resistance in pounds per ton. At 100 miles per hour this would only amount to 13.1 pounds per ton, to which is to be added (1) the axle friction of two pounds per ton, and (2) whatever one pleases for the oscillatory and concussive resistances increasing with speed. These last are certainly considerable at very high speeds, but there is absolutely no means of estimating them with accuracy.

6. It is now an admitted fact that the axle friction at the instant of starting is many times greater than after the vehicle is once under way, and that the drop from this high resistance, while very rapid, is by no means instantaneous, but requires a speed of from 5 to 10 miles per hour before the normal rate is attained. The starting resistance at times rises considerably above 20 pounds per ton, *i. e.*, a car on a one per cent. down grade, which gives an accelerating force of 20 pounds per ton, will not always start of itself without aid. A force of 16 pounds per ton will very rarely start a car in motion. A fair average is about 20 pounds.

All these various data we have plotted on a little diagram reproduced herewith, to which we have added a solid black line to show what the evidence at hand appears to indicate as to the true rate of train resistance in pounds per ton. The six observations on high speed trains are shown by small circles with the name of each observer attached. Above and below these are shown by dotted lines (1) the old Clark formula as one extreme and (2) the Crosby formula for air resistance as the other. The range of the older formulas at 10, 20 and 30 miles per hour is shown at the left. There have been some showing still higher resistances than Clark's, but they have not met general acceptance. For the most part they fall below Clark's at low speed.

Considering that the Worsdell observations are known to need small correction at least, Mr. Sinclair's two records come extraordinarily near to giving the mean of the four others. If we add to the Worsdell observations six pounds and 10 pounds per ton respectively, which would be the effects of a 0.3 per cent. and a 0.5 per cent. grade (15 and 26 feet per mile), they would fall exactly on the line which we have drawn as the "weighted mean" of the six, allowing most weight to Mr. Sinclair's observations.

Is it possible to find in this diagram any support for the theory that train resistance varies as the square of the velocity? We are unable to do so; especially as it is easy to see how the facts which we have narrated should make resistance observations within a narrow range of low speeds only appear to indicate that the velocity resistances vary as the square or even a higher power, when they really varied directly with the velocity. We by no means give our adhesion to the latter theory. We are merely weighing evidence. We do not say that so far as the existing evidence as to high speeds goes, all of it supports the latter theory and none of it the older and heretofore accepted theory. If the solid line on the diagram gives a true mean of trustworthy experiments, then the resistance of passenger trains at speed is given by the equation.

$$R = 0.24\ V + 2,$$

or perhaps as accurately and more simply :

$$R = \tfrac{1}{4}\ V + 2.$$

Both these forms are subject to a slight increment for difference in axle friction at speeds below 40 miles per hour, increasing as the speed falls, which is a more or less variable quantity and for practical purposes may be neglected.

We shall watch with much interest to see how further developments correspond with this formula. It is entirely possible that they may discredit its form, or even its substance. But until they do, and for the present, experimenters at high velocities of over a mile a minute can have no better guides as to the true resistance, we think, than the above formula, and this fact at least seems to be now established beyond peradventure that high-speed train resistances are very much lower than has heretofore been supposed, or than has even seemed possible.

*See THE ELECTRICAL WORLD, May 24, 1890, p. 346.

The Robb-Armstrong Engine.

We illustrate on this page a new single automatic engine recently brought out by the Robb Engineering Company, of Amherst, Nova Scotia. In general appearance it does not differ greatly from several popular high speed engines, and no radical departure has been made in principles of construction, the aim being to combine as many as possible of those points which have proven best in practice, with such improvements in details as have been suggested by observation and experience with other engines.

The frame is of the Porter type, with double disc crank; it has considerable sectional area, carried well above the centre line, and is particularly thick at the top, thus bringing the metal in the direct line of strains between the cylinder and shaft bearings.

The crank is built up of cast discs and forged steel pin and shafts, the peculiar arrangement of the crank permitting the fits of the shafts and pin in the discs to be very long, without separating the shaft bearings unduly, as is shown in the cross section at the right of Fig. 2; the counter weight is of equal moment with the reciprocating parts. The shaft bearings run in cast-iron shells, babbitted; they are not provided with means of adjustment for wear. The bearings are finished by grinding operations of great delicacy, and are round and parallel within a limit of variation smaller than the average machinist will usually detect, even with the aid of the micrometer. The shafts are made to gauge, and the shells are interchangeable, as are the other parts of the engine; hence, a duplicate set of shells may be kept for emergencies. The crank is covered by a cast-iron case shutting it completely in except at the slot through which the connecting rod works. The crank discs are without the usual finished flanges on the periphery, the crank case being designed to have a substantial and finished appearance, and free access is given to the crank-pin box, when the hinged crank case is raised. The crank-pin is oiled through two half-inch holes, one extending from each side of the crank to the centre of the crank pin, all oil wasting from the inner ends of the shaft bearings being instantly carried to the crank, while all oil wasting from the outer ends of shaft bearings is caught, and by a ring riding on the top of shafts and dipping into the oil below, is returned again and again to the bearing, until it finds its way to the crank pin and escapes to the crank pit, to be drawn off and filtered.

The flywheel governor is a modification of the "Straight Line," and, together with the valve, is used by arrangement with the Straight Line Engine Company; the oiling devices mentioned will also be recognized as essentially "Straight Line."

The eccentric rod, so called, although there is no eccentric, has ball and socket bearings at each end, the balls being case-hardened and ground, and the sockets or boxes of phosphor-bronze. The rocker arm, by which the eccentric rod drives the valve, is horizontal, with a vertical axis; there is no twisting strain on either of its bearings, a straight line passing through all three of them.

A small sight-feed oil cup, directly over the centre of the rocker arm, supplies oil through a tube to the outer end of the arm. The eccentric rod is hollow, being, in fact, a piece of hydraulic pipe, and through it the oil passes to the eccentric pin, any oil finally escaping being caught and held in the flanged flywheel.

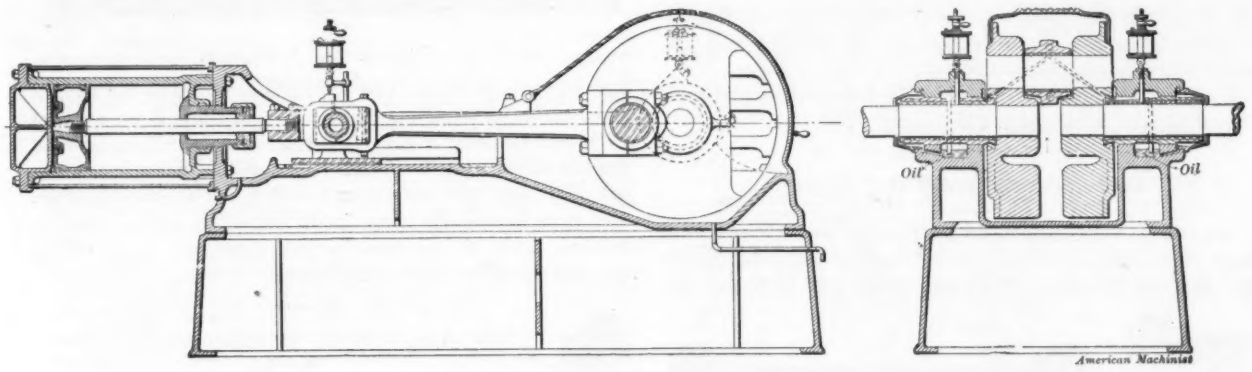


FIG. 2.—ROBB-ARMSTRONG ENGINE.

The crosshead is a single steel casting, of the "Slipper" type, the bottom of the slipper being babbitted. The piston rod is secured by being gripped in two places, about two inches apart, one place being threaded and the other a parallel fit. The crosshead is split, and is gripped on to the rod by bolts. The crosshead pin is of cast iron, as it is believed that, in connection with the large and long bearing, it is the best material for the place. The connecting rod is a steel forging, the crank end being of the marine type, while the crosshead end is mortised for boxes, which are cast iron, lined with babbitt. The adjustment is by a wedge and adjusting screws. The exhaust passages are jacketed by air spaces from the cylinder, and from the live steam in the steam chest. The throttle is a modification of the Coffin valve used by the Straight Line Engine Company, but is operated by a lever instead of a wheel or ball handles. The engine was designed and its manufacture organized by Mr. E. J. Armstrong, who is now with the Ames Iron Works, Oswego, N. Y., which company will also build the engine in this country.

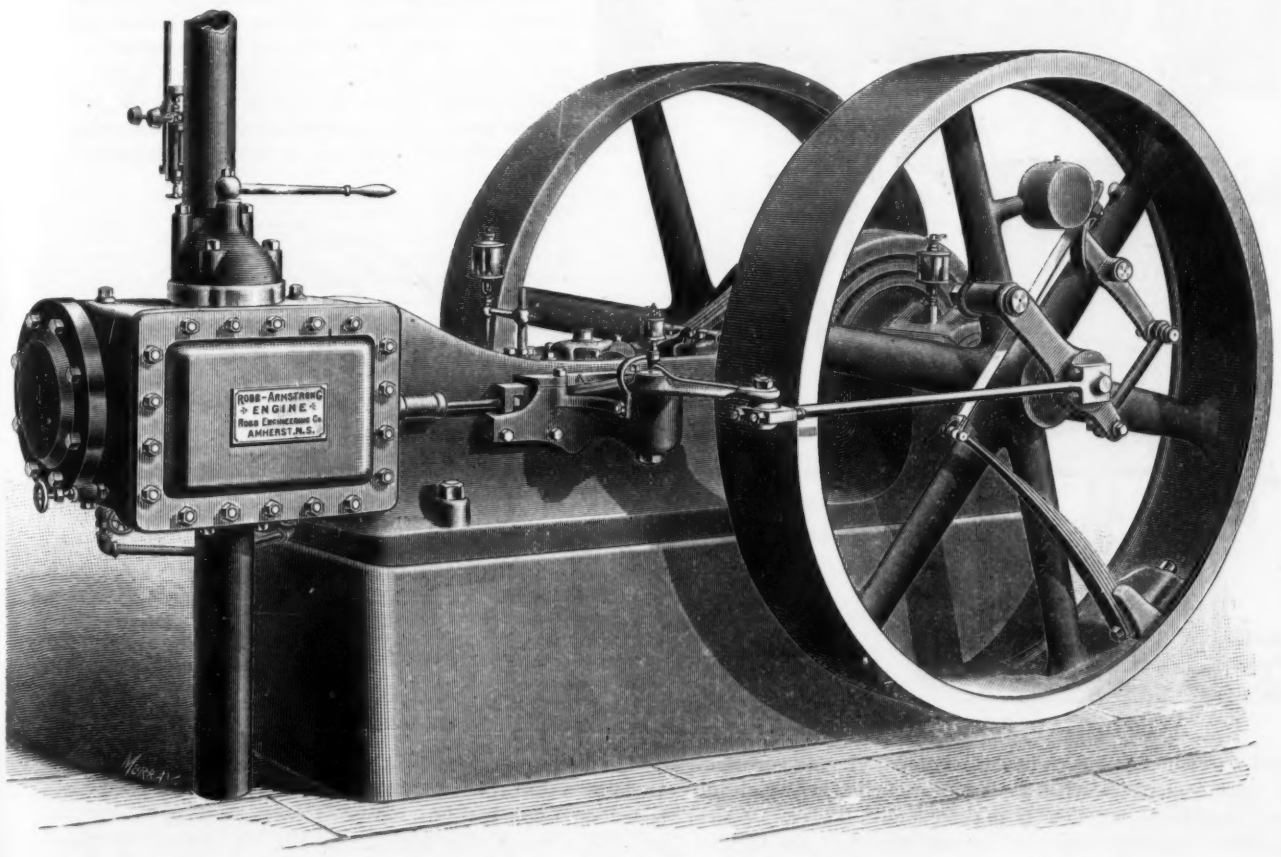
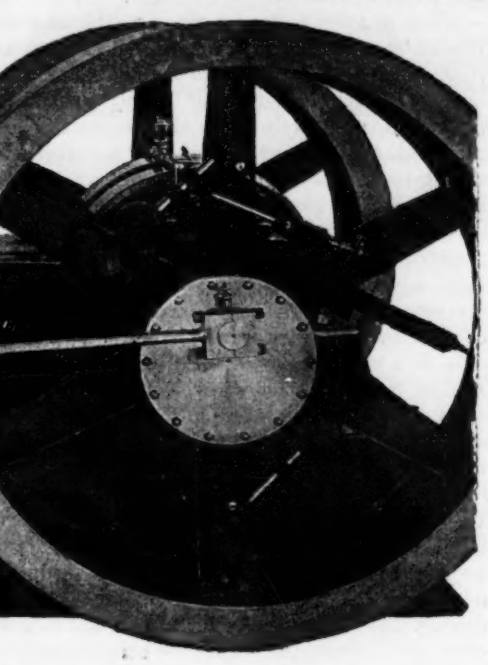


FIG. 1.—THE ROBB-ARMSTRONG ENGINE.



BALL HEAVY DUTY ENGINE.

Heavy Duty Engine for Electric Railway Service.

The widely varying load which a steam engine in an electric railway power station is so often called upon to carry calls for the fulfillment of special conditions, prominent among which are great strength and prompt acting of the governing mechanism. It was through lack of one or both of these essential points that some of the engines in the early installed stations have shown themselves unfit for the task assigned them.

In the accompanying illustration is shown an engine recently brought out by the Ball Engine Company, of Erie, Pa., especially for electric railway service. It will be seen that this engine is, for its cylinder capacity, of great strength and weight, the makers claiming that the engines they build are, for the horse-power, the heaviest engines made. The connecting rod and crank shaft are of forged steel. The crank shaft is 8 inches diameter in the crank pin and in the journals. The crank pin boxes are lined with strictly genuine babbitt, the cross-head boxes are of pure copper and tin. The cross-head pin is of tool steel. The system of oiling the running parts is very simple and thorough. The valve which has been used by this company with such success in the past in the electric light engines is continued in the heavy duty engine. This engine, it is claimed, has shown in practice perfect regulation under conditions where the variation of load on the generator from zero to the full capacity has occurred during less than five seconds of time. The very best possible material and workmanship throughout is used.

Safe Wiring.*

BY A. B. SMITH.

In presenting a few remarks I shall make under the heads of safe wiring it is not my intention to enter into a lengthy description of what may be termed mechanically safe construction. It would be impossible to do this, as the conditions to be met in general work are so diverse. In fact it may be said that no two installations in existence are exactly alike. On a few points there are some rules that apply invariably, but I intend rather to look at it generally from a "moral" standpoint. For instance, it is well known that dampness is a mortal enemy to successful results. To guard against this it is necessary that every man engaged in an installation, from the highest and best paid men to the mere laborer, should conscientiously do his part. I need scarcely point out to you that the interests of the electric lighting fraternity and that of the insurance companies are identical. A failure to get good results, or a risk of serious loss, is a detriment to one as well as the other. I lay great stress on the importance of conscientious work by individuals rather than on the laying down of rigid rules. It is impossible to make a hard and fast rule to cover every minute detail of installation, and therefore without this dependence on the honesty of the workmen very little in the way of safeguards can be actually accomplished. Safe wiring is more a matter of men and material than of method.

I know of no business on the face of the earth where the public and the insurance companies have to depend more on the individual reliability of the workmen than in this one. On account of the immediate concealment of work

* A paper read at the first annual meeting of the Canadian Electrical Association.

almost before it is completed, opportunities to do negligent work are abundantly offered, so that it requires more than ordinary conscientiousness in men engaged in the work and circumspection in its oversight.

While in a few instances much trouble and annoyance is caused by unskilled electric men, who have an idea they possess more knowledge than can be carried by one single brain, still there is a source of trouble to electric light people and the underwriters which is most serious. What I refer to is the ignorant and clumsy interference with good wiring by plumbers, steam and gas fitters and other pipe men, and our friend the ubiquitous bell hanger. These individuals, with supreme contempt of others' rights, or through ignorance, not realizing the danger of their practices, are constantly making mischief. Nine cases out of ten where trouble is located in an otherwise perfect piece of work these pirates are to blame.

It is a common occurrence to find gas or water pipes resting upon electric wires, these pipes or other iron work having been placed in position after the electrical work has been completed. Furthermore, there is a certain class of men, especially gas fitters, who really have an idea that they do know something about electricity, and who believe that because wires are sometimes run in pipes, that it is their special vocation to do it. It is true in this as in other matters, that "A little knowledge is a dangerous thing." Unfortunately the public have no protection against these half-baked electricians, and it is against this class of work that the insurance companies have to fight their greatest battles. Serious loss has only been averted by constant and skillful supervision, and were it not so the loss from this source would be vastly greater.

There are only one or two points in reference to construction work of general application which I would like to refer to. One of these is the use of cleat work in cellars and other places liable to dampness, unless a sufficiently protected wire with a superior insulation to ordinary weatherproof is used; in fact I would much prefer to prohibit absolutely the use of cleats altogether in places liable to the slightest dampness.

Also, a word of warning will not be out of place against the indiscriminate use of porcelain knobs for outdoor purposes. These knobs are good and useful in their proper place, but the average lineman seems to imagine that porcelain is a panacea for all the evils that afflict a wire.

In closing, I desire to sincerely congratulate the members of the Association on the cordial relations now existing between the underwriters and the electrical fraternity. The future maintenance of this happy condition remains in your keeping. By employing none but thoroughly reliable men and using good materials the present insignificant percentage of loss by fires of electric origin will be rendered still less.

The Hercules Switch.

The accompanying cut shows the Hercules switch, which the Utica Electrical Manufacturing Company, of Utica, N. Y., is bringing out. This switch has double contact and is very quick in its action. It is intended for either arc or power circuits. The binding posts and contacts are very heavy, it is mounted on a slate base and inclosed in a water-tight iron case, and currents of from 25 to 100 ampères of any voltage can be safely handled. The switch is automatic in its action, and does not depend on the speed of the

HERCULES SWITCH.

movement of the operator's hand. The case has porcelain bushings for protection of wires in entering and leaving the box. No. 1 is eight inches in diameter, while No. 2 is only six inches, making a very compact arrangement.

Lunkenheimer's Automatic and Plain Grease Cups.

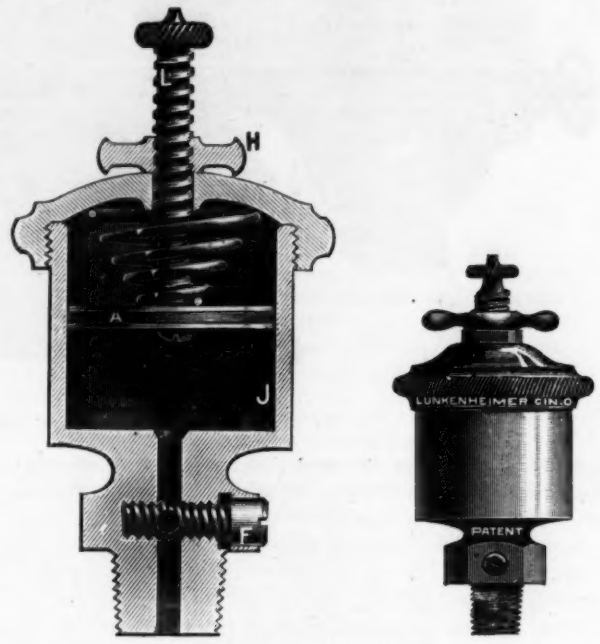
The Lunkenheimer automatic spring grease cup is provided with a leather packed plunger, which can be raised from the outside by means of the thumb nut. The plunger is so constructed that it is easily raised when the cup is empty, as a vacuum cannot form under it.

To use the cup turn the thumb nut *H* to the right until the plunger is drawn to the top of the cup, then unscrew the cover and fill the cup with grease. Replace the cover and adjust the pressure on the grease by screwing up the thumb nut *H* to the top of the stem *L*, thereby allowing the plunger to compress and feed the grease. The rate of feed must be regulated by the set screw *F*.

If it is desired to stop the flow of grease, turn the thumb nut *H* down to the cover, thereby taking the tension off the spring.

The plunger *A* is provided with a soft leather washer, which insures a tight joint and smooth working.

The Lunkenheimer plain grease cup is well adapted for jarring machinery, traction engines, etc., as it will not jar apart nor will the cover unscrew itself.



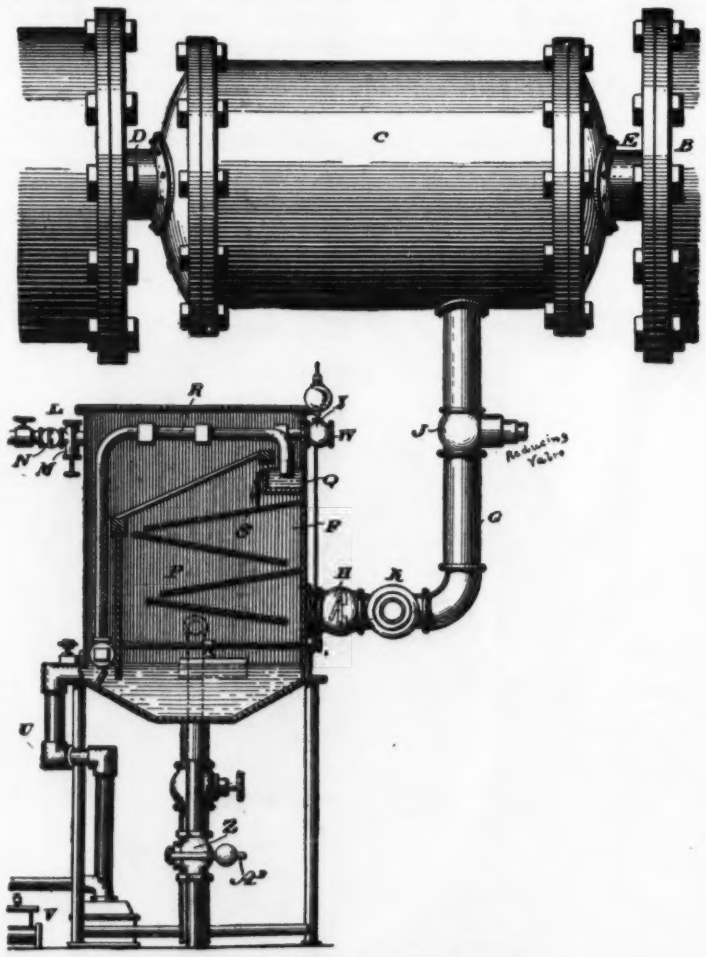
Lunkenheimer Grease Cup.

By screwing down cap every three or four days it is said that sufficient lubrication is given. The leather washer prevents the grease from leaking out of the cup, and can easily be replaced when worn out.

These cups are manufactured by the Lunkenheimer Brass Manufacturing Company, Cincinnati, O.

An Improved Feed-Water Heater.

In order to attain the best economy the feed-water should enter the boiler at 212 deg. F. To accomplish this result Mr. Warren Webster, of Philadelphia, has designed the

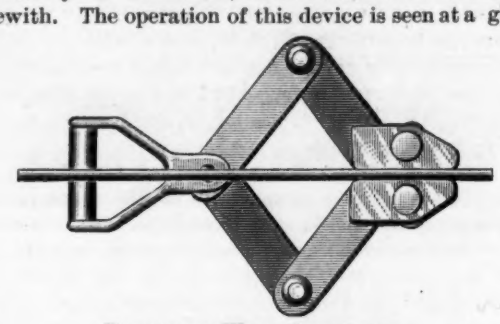


IMPROVED FEED-WATER HEATER.

feed-water heater shown in the accompanying illustration. A branch pipe C_1, with a pressure-reducing valve, leads from the steam receiver *C* to the vacuum heater. Water is taken from the hot well or coil heater at the highest temperature possible and fed into a water inlet *W*. Steam taken from the steam receiver through the pipe *g* is used to heat this water up to 212 deg. This steam has already given up part of its energy in passing through the steam cylinder or cylinders. Only just the quantity of steam necessary to heat the water to the proper temperature is taken from the receiver, and the valve in the pipe reduces the pressure to as near that of the atmosphere as possible. In this way the maximum amount of water is heated by the minimum amount of steam. The air in the heater escapes by the pipe *z*, the check-valve *N* preventing its return unless the vacuum is too great, when the inlet air valve *M* automatically admits the required amount. A discharge pipe *U* conveys the feed-water from the heater to a pump *V*.

The Isham Parallel Wire Stretcher.

A very simply parallel wire stretcher, recently put on the market by A. D. Isham, of Buffalo, N. Y., is illustrated herewith. The operation of this device is seen at a glance.



Parallel Wire Stretcher.

It is made of steel and will stand any amount of hard service. There are no teeth to injure or mar the wire. The pull is a direct one. It is claimed that it will never slip. Its simplicity is very commendable.

Cordage for Electrical Purposes.

The accompanying cut illustrates and given a very good idea of the kind of braided cord that the Silver Lake Company, of Boston, is manufacturing to suit the wants of the electrical trade. It is put up in hanks of 100 feet each, two lines connected, with one dozen hanks in a package, or in coils of any length as ordered. It is made in all sizes, varying by thirty-seconds of an inch in diameter so that it can be adopted to suit any pulleys. By the process now

Electrical Cordage.

employed in finishing the stretch is removed so the weight soon settles to its permanent place, and there is no untwist by which the cord can lengthen as it wears. It is claimed for the Silver Lake cord that in unwinding it does not kink, but comes out smoothly, thus saving much time and trouble. This cord is manufactured for hanging arc lamps, winding around fields of dynamos for protection purposes, and for signaling purposes in street railway service.

The Bernstein Alternating Current Fan Motor.

The Bernstein Electric Company, 620 Atlantic avenue, Boston, has just brought out a new alternating current fan motor, which is shown in the accompanying illustration. This motor is wound for either 50 or 100 volt alternating circuits or for other voltages when specially desired. There is no electrical connection between the fields and armature and a heavy excess of potential can be withstood without undue heating or danger of burning out. There is only one brush and the motor runs without sparking and without noise. It has self-oiling bearings, a bronze commutator

BERNSTEIN FAN MOTOR.

and embodies the very best mechanical workmanship. It is claimed that this motor when driving a 12 inch fan at a speed of 1,600 revolutions consumes only 65 to 70 watts, which is a result that continuous current motors of like size cannot obtain.

Electric Locomotives on the City & South London Railway: A Correction.

To the Editor of The Electrical World:

May I ask space to correct a passage in the newly published fourth edition of my "Dynamo Electric Machinery?" On page 616 occurs the statement, altogether incorrect as I now find, that the original locomotives of the City & South London Electric Railway "are now being replaced" by

others. My sincere apology is due for any inconvenience or annoyance caused to Messrs. Mather & Platt, Limited, by such a statement. It should be pointed out that all the 14 original locomotives constructed by Messrs. Mather & Platt are still running, and have run in the aggregate more than 500,000 miles, and have provided for a traffic of more than 7,000,000 persons. The two locomotives supplied by Messrs. Siemens do not replace but merely supplement the original locomotives; and the rolling stock will shortly be still further increased, as I now learn, by another locomotive now being constructed by Messrs. Mather & Platt.

SILVANUS P. THOMPSON.

June 14, 1892.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK AND BOSTON, June 30, 1892.

General Financial Market in New York.—The week has been attended by various vicissitudes, having contradicting effects. The refusal of Drexel, Morgan & Co. to undertake the reorganization of Richmond Terminal was a feature which had the greatest effect on speculation. The action of the coal sales agents in advancing prices was calculated to materially advance coal stocks. The export of gold for the week to Thursday amounted to $500,000 engaged for European shipment and $300,000 for Canadian shipment. It is believed that this will be all the gold that will go out this week. The total of $800,000 is to be compared with $5,250,000 of last week, $7,100,000 for the week preceding. Thus it will be seen that there has been an almost total suspension of exports, a condition which will be apt to continue till next week. The Stock Exchange takes a holiday from Friday, July 1, to Tuesday morning, July 5. Money on call was a little firmer this week, being 1¾ to 2 per cent. Time loans have not changed materially.

New York Electrical Stock Review.—Transactions this week have been confined to eight or ten of the leading stocks in the accompanying list, and for the most part showed an increased activity over the previous week, and slightly better values. American District Telegraph was in some request, being bid at 61¼, held at 63 and 64. American Telegraph & Cable increased ½ to 86½ on holdings, and was quite frequently bid 85. On Monday Commercial Cable, which sold during the previous week at 155, was held at 155½; on the following day it was firm at 156; no sales are recorded. Western Union was even more active than usual. The reopening of the books after the payment of the dividend caused the stock to sell off about a point as stated in our last report. On Tuesday and during the remainder of the week it recovered, reaching 94⅛ on sales. The stock is all in a few hands, and insiders are evidently just at the present time desirous of keeping it as near par as possible. S. V. White continues to engineer its career on the stock exchange. There were several large transactions in Western Union bonds. We note sales of 5,000 collateral trust 5's at 106 and collateral trust 6's to the extent of 2,000 at 106¼. General Electric, which has now been listed a little over a week, was very actively inquired for and equally as firmly held. It was bid 107½ early in the week and later advanced to 108, being held as high as 108½; sales took place at figures ranging from 108 to 108⅜. Edison Electric Illuminating sold 100 shares on Tuesday at 85; this is about the figure which ruled last week. Several blocks of its bond securities were traded in as follows: 2,000 general 5's at 101½; 4,000 firsts at 102; second lot of 4,000 firsts at 101¾. North American led a very active week, and on reports that the finances of the company, as well as those of Mr. Villard in his Northwestern enterprises, are being materially improved, caused an advance of about one point. The last sales were at 14 to 14¾.

The General Market in Boston.—This week's market has been exceedingly dull and devoid of all interest to the public. Prices have been unsettled and inclined downward, but a moderately strong undertone has been sufficient to prevent any raiding by the bears, and likewise any raising of values by the bulls. London has not been a prominent feature either to buy or sell. July will bring better conditions later in the month, for the semi-annual disbursements have an important influence on values. The granger railroads and industrial stocks have furnished most of the week's sales. Considerable arbitrage business is continually done. New York funds have sold at a discount of five to eight cents in Boston just previous to the date for interest payments. The small gold shipments have not cut an important figure in the market, as they have been discounted about as soon as announced. Rates on loans are unchanged, at very low figures. The transactions are small; and if sellers are only willing to advance the rate a little, more paper could be sold. Short loans are more acceptable than long ones at such low rates as at present, for bankers look for better conditions in the autumn, and want to have access to their funds then.

The Electrics in Boston have not been quite so dull as the other stocks on the list, but have had a very quiet week, devoid of interest. The prices have remained almost the same as for some time past, with only fractional changes. There are no adverse reports or internal influences to affect in any degree these stocks, but their quietness is due only to a lack of buying orders to stimulate prices and interest. Meantime, however, their strength is noticeable. Thomson-Houston is still on the Boston Exchange, and its price will give General Electric stock a good premium when it is opened. It has remained strong around 64. Westinghouse common has fallen about a point on small sales, while the preferred is not materially changed. The scrip is quoted firmer in Pittsburgh at 85 to 90, though there have been no transactions for some weeks. A recent inquiry for North West Thomson-Houston brought out a bid of 103 for the common, and 115 for preferred. Bell Telephone has reached a high mark again, 208, having made a rapid advance from the price to which the adverse dividend report sent it recently.

Electric Bonds now figure largely in the offerings of the best banking houses and are rapidly growing in favor throughout the market. Lamprecht Bros. & Co., of New York and Boston, among other bonds offer East Middlesex Street Railway 5 per cent. bonds, dated Jan. 1, 1892, due 1902. The authorized capital stock of the company is $300,000; amount fully paid in $200,000; bonds outstanding $225,000. These bonds are issued to equip the road with electricity. The company owns 15 miles and operates 20 miles of street railway in Malden, Mass., and the adjoining towns, aggregating in population about 100,000 inhabitants. The management of the company is practically that of the Lynn & Boston Street Railway Company, which for ten years has paid 8 per cent. dividends. The directors include many of the foremost business men in Lynn, and some in Boston. The bonds are held by some of the leading insurance companies in Massachusetts and are recommended very highly. The same firm also offer $100,000 of first mortgage 6 per cent. Ottumwa Electric Railway bonds of Ottumwa, Ia., dated June 1, 1892, due 1912. A sinking fund of $5,000 a year will be deposited with a treasurer after 1897 to retire this amount of bonds annually. The capital stock of the company is $500,000, of which there is issued and outstanding $300,000. Total first mortgage bonds $200,000. Cash cost of property 1892, $425,000. The company own 7¼ miles of track and operates 11 cars. It also has a valuable electric lighting business, which is constantly increasing, and in addition to this a valuable steam heating system with 2¼ miles of mains in the streets. The net earnings for 1891 were $18,000, a gain of 70 per cent. over the previous year. With the present additions to the plant completed, it is expected that the earnings for 1892 will be more than double those of 1891. A large portion of this issue of bonds was taken by the citizens of Ottumwa, thus endorsing the value of the property. The bonds are offered at 101 and interest with a strong endorsement of their value. Brewster, Cobb & Estabrook, of Boston, offered $20,000 Cambridge (Mass.) Street Railways 5's, due April, 1903, at 106⅛, yielding 4¼ per cent.; and $21,000 Highland Street Railway 5's, due May, 1902, at 106, yielding 4¼ per cent.

The Thomson-Houston International Electric Company.—This corporation was taken into the General Electric Company on the basis of one share of stock of the latter at par to $240 per share of the former. This company owns the right to use the patents of the Thomson-Houston company in all countries except the United States.

The Mexican Telegraph Company reports the following operations, partly estimated, for the quarter to end June 30, the figures being as of May 31, 1892:

Surplus above April dividend		$246,764
Receipts	$82,731	
Operating costs	17,500	
Balance	$65,231	
Dividend, July 9	47,815	
		17,416
Surplus		$264,180

Increase in Capital Stock.—The Joliet, Ill., Street Railway Company has certified to an increase in capital stock from $150,000 to $300,000. The directors of the Springfield, Mass., Street Railway Company have voted to ask the State Board of Railroad Commissioners for authority to increase the capital stock $300,000, making the aggregate $1,000,000. The Bell Telephone Company, of Philadelphia, will hold a meeting this month to vote on the question of increasing the capital stock from $600,000 to $1,000,000. It is proposed to increase the capital stock of the Southern Massachusetts Telephone Company by $50,000. The Edison Electric Light Company, of Salida, Colo., has certified to an increase in capital stock from $30,000 to $50,000.

Dividends.—The Mexican Telegraph Company has declared a 2½ per cent. dividend for the quarter, payable July 9. The Perkins Electric Switch Manufacturing Company, of Manchester, Conn., has declared a dividend of 3 per cent.

The copper market continues dull and dispirited. Current production is moving forward by way of the lakes to the Eastern market and is going into consumption. As near as can be learned, most of it is being taken by companies manufacturing electrical apparatus. The price has not changed materially in the week; contracts for a month's delivery can be placed at about 11¾ and 11⅞ cents. Casting brands are selling at ⅛c. lower than this figure.

Closing Quotations.—The following were the closing quotations of electric stocks on Thursday, June 30, 1892, in New York, Boston and Chicago.

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Lowest.	Highest.	Bid.	Ask'd.
American Bell Tel	100	17,500,000	....	....	....	..
Debentures subject to call at 100	...	2,000,000	...	....	....	..
American District Tel	100	3,825,000	....	....	61	63
American Tel. & Cable	100	14,000,000	....	....	85	86½
Central & So. Am. Tel	100	6,000,000	....	....	....	..
Commercial Cables	100	7,716,000	....	....	155	156
Debentures	...	1,000,000	....	....	....	..
Erie Tel. & Telp	100	4,800,000	....	....	....	..
Gold Stock & Tel	100	5,000,000	..	....	100	103
Bonds	500	500,000	....	....	100	..
Mexican Tel	100	2,000,000	...	....	....	..
Northwestern Tel	50	2,500,000	....	....	....	..
First Mort. Sinking Fund	500	1,180,000	...	....	....	..
Postal Tel. & Cable	..	10,000,000	....	....	62	64
Southern & Atlantic Tel	25	948,775	....	....	78	84
Western Union Tel	100	15,000,000	91	94⅛	93¾	94¼
Real estate bonds	1,000	1,219,000	....	....	....	.
Debenture bonds	1,000	4,920,000	....	....	....	..
" sinking fund bonds	500	841,266	....	....	....	..
Collateral Trust 5's	1,0 0	8,181,000		106	....	.
North American	100	39.767,200	13⅛	13⅛	13¼	13⅜
Brush Ill. Co. of N. Y	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y., ex-right	100	6,500.000	....	85	....	....
Edison El. Il. of Brooklyn	100	750,000	...	....	85	90
" " " " Chicago	100	750,000	....	....	130	145
" " " " Boston	...	.....	....	....	115	126
Edison El. Lt. Europe	1,000	2,000,000	....	....	2	6
" Bonds	...	30,000	....	....	65	80
Edison Ore Milling Co	...	2,000,000	....	....	15	20
East River El Light	100	1,000,000	....	....		65
General Electric	1,000	50,000,000	168	108¾	108¼	108⅜
Automatic Exhibition Co.	...	2,500,000	....	....	3	5
Mt. Morris Electric	...	500,000	....	....	....	65
N. E. Phonograph	..	2,000,000	....	....	2	4
N. Y. Phonograph	...	2,000,000	....	....	2	5
North American Phonograph	...	2,000,000	....	....	4	6
Westinghouse Elec & Mfg. Co. 1st p. 7 per cent. Cum.	50	3,717,253	....	....	....	....
E. & M. Co. Assg	50	5,038,116	....	....	....	..

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec	25	6,000,000	65	64¼	64¾	65
Thomson Houston Elec. preferred	25	4,000,000	30	29½	29½	29¾
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8	9
Thomson-Houston Elec.—Series D	sh	120,000	7⅜	7¼	7¼	7⅜
Thomson-Houston Int'n'al Elec	100	600,000	....	....	250	260
Thomson-Houston Int'n'al Elec—Pfd	100	400,000	....	....	103	105
Thomson Elec. Weld	100	1,000,000	....	....	55	60
Thomson European Elec. Weld	100	1,500,000	....	12	....	15
Westinghouse Elec.—New Com.	..	6,000,000	28⅝	28	28½	29¼
Westinghouse Elec.—Pfd.	..	4,000,000	46¼	45¾	....	45½
Fort Wayne Elec	25	4,000,000	12½	....	12½	12⅝
Fort Wayne Elec.—Ser. A.	sh	80,000	7⅜	....	7¼	7⅜
Detroit Elec	10	1,000,000	....	....	7	8
West End St. Ry. Co.—Com	50	7,150,000	73¾	72⅝	72	72⅛
West End St. Ry. Co.—Pfd	50	6,400,000	88⅞	88½	88⅛	88¾
American Bell Tel	100	15,000,000	209	205½	*200	202
Erie Tel. & Tel. Co	..	4,800,000	44	43¾	43¾	44¼
Mexican Tel. Co	10	1,280,000	1.05	1.00	1.02½	1 05
New Eng. Tel. & Tel. Co.	..	10,304,600	55½	....	55	56
Tropical Tel. Co	10	400,000	20	....	20	50

*Ex-dividend.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stock furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.
Chicago	221	..
Central Union	56	56½
Michigan	87	90
Wisconsin	..	139
Missouri & Kansas	..	56

Electrical Stocks:	Bid.	Ask'd.
Iowa Union	20	25
Chicago Arc Light & Power Co	92¾	93½
Chicago Edison Co.	160	..

NEW INCORPORATIONS.

The Bacon-Tyler Company, of Berwick, Me., capital stock $250,000, has been formed to manufacture and deal in electrical and other devices. Chas. N. Rogers, Henry S. Bacon, W. H. Tyler, E. F. Thompson, Worcester, Mass., and H. V. Moore, Berwick, Me., are those interested.

The Gray European Telautograph Company, of Chicago, Ill., has been incorporated with a capital stock of $100,000, to manufacture and deal in telautographs and other electrical devices, etc. Chas. P. Treat, James W. Chisholm and Frederick W. Cushing are the incorporators.

The Northwestern Electric Fixture Manufacturing Company, of Chicago, Ill., capital stock $2,000, has been formed to manufacture and sell electric, gas and combination fixtures and parts thereof. Charles Laubmayer, James P. Holmes and Lessing Rosenthal are the incorporators.

The North Kankakee Electric Light and Railway Company, of Kankakee, Ill., capital stock $30,000, has been formed to furnish electric light, and to build and operate an electric street railway. The promoters are J. H. Hardeback, Walter W. Hatch and August D. Ehrich.

The Electric Power Company of Staten Island, of New Brighton, N. Y., capital stock $250,000, has been formed to produce electricity for light, heat and power. Wm. Dwight Wiman, Norman S. Walker, Jr.; Sam. H. Libby and Erastus Wiman, all of New Brighton, are the incorporators.

The Schlichting & Smith Company, of Brooklyn, N. Y., capital stock $75,000, has been incorporated to manufacture sheet metal goods, electrical appliances, etc. A. T. Schlichting, 187 Pearl street, Brooklyn, N. Y., and Julius Smith, 187 Pearl street, Brooklyn, N. Y., are the parties interested.

The American Electric Rock Drill Company, of Jersey City, N. J., capital stock $250,000, has been incorporated to manufacture and operate rock drills. R. G. Hollaman, C. E. Burke, Brooklyn, N. Y.; R. J. Horner, New York, and A. B. Archibald, of Jersey City, N. J., are the parties interested.

The Kansas City Gas and Electric Company, of Kansas City, Mo., capital stock $10,000, has been formed to acquire, own and construct gas and electric works, and to supply electricity and gas for heating and power purposes. Geo. H. Nettleton, J. S. Chick, and George Kimpf, of Kansas City, are the organizers.

The Plate Valley Electric Railway Company, of Denver, Colo., capital stock $500,000, has been formed to construct and operate an electric railroad from Denver to Brighton. D. F. Carmichael, N. Brighton, Jerry N. Hill, Edward A. Reser, David J. McCanne and John A. Thompson, of Denver, are the organizers.

The San Francisco Electric Storage Company, San Francisco, Cal., capital stock $1,000,000, has been formed to manufacture and deal in electrical machinery and generate and deal in electric light and power. D. Gilbert Dexter, C. B. Sessions, S. C. Mills, H. W. Spaulding, San Francisco, and E. J. McCutchen are the promoters.

The Washington Park & Spring Grove Railway Company, of Sioux City, Ia., capital stock $150,000, has been formed to maintain and operate a street railway by motor or electricity. Ed. Haakinson, Daniel T. Hedges, Wm. V. Hedges, Carl E. Haakinson and E. H. Haakinson, of Sioux City, are the parties interested.

Boston, Mass.—At the meeting of the Railroad Commissioners the question of elevating the railroad tracks at Grafton street (Worcester) was taken up, but a decision on the matter was postponed until July 6. The roads interested in this matter are the Boston & Albany, the Providence & Worcester and the Norwich & Worcester.

The Manhattan Electrical Supply Company, of Jersey City, N. J., capital stock $20,000, has been formed to manufacture and sell electrical apparatus, machinery, etc. H. T. Johnson, John J. Gorman and James Pembroke, all of New York City; Richard Fodan, Greenville, and Edgar Whitmore, of Brooklyn, N. Y., are the parties interested.

The Cadiz Electric Light and Power Company, of Cadiz, O., capital stock $15,000, has been formed to furnish electricity for illuminating and mechanical purposes. W. W. Wright, C. S. Scott, C. A. Holmes, Jas. M. Sheriff, Jas. B. Rigers, C. F. Brown, W. L. Sharp, W. T. Wood, C. Brown, Fred. D. Perry, L. B. Lamb, A. B. Sheriff, E. H. Atkinson, C. C. McCoy and M. J. McCoy are the incorporators.

The Santa Ana Electric Power and Development Company, of San Bernardino, Cal., capital stock $1,000,000, has been formed to generate power by water and transmit by electricity, and to build and operate electric plants, railroads, etc. Andrew B. Paris, F. C. Finkle and W. S. Hooper, all of San Bernardino, and William H. Goucher and E. M. Frazee, both of Los Angeles, are the promoters.

The Dion Magneto Electric Company, has been organized with O. Ames, president, E. F. Atkins, treasurer, and L. R. Green, general manager, and other directors, R. Tarr and L. Dion. The company is capitalized at $1,000,000, and controls the device patented by L. Dion for propelling street cars without the use of the overhead trolley. The company proposes to at once put the invention into practical operation

The Cuyahoga Falls and Akron Railway and Power Company, of Cuyahoga Falls, O., capital stock $100,000, has been formed to construct, operate and maintain a street railroad to be operated by electric or other motive power, and for the purpose of furnishing electric power, etc. W. J. Price, G. F. Parmelee, G. F. Harris, James Anthony, S. S. Leonard, R. H. Carlisle and Z. M. Hubbell are the organizers.

The Denison Normal School Association, of Denison, Ia., capital stock $60,000, has been formed to operate an electric light plant, erect a school building, etc. The promoters are C. Sievers, J. H. Carstens, R. Heffelfinger, M. Goldheim, W. J. Schriver, T. J. Garrison, Joseph Brogden, P. E. C. Lally, Henry Kelly, C. Green, C. Gronan, L. M. Shaw, J. B. Romans, A. C. Balle, C. F. Kuehule and F. W. Mueller, of Denison.

AFFAIRS OF THE COMPANIES.

The Stock (of the Rochester, N. Y., Electric Light Company) has been purchased by individual stockholders of the Edison company.

The Consolidated Electric Company, of Worcester, Mass., is to establish a wire company in St. John, N. B., for the purpose of making a new kind of insulated wire.

Springfield, Mass.—The stockholders of the street railway company have unanimously voted for an increase of capital stock to be devoted to the construction of extensions already under way.

The Carpenter Enamel Rheostat Company, of St. Paul, Minn., has leased a skating rink in Bridgeport, Conn., and is

nsforming it into a factory. The company will start with 50 employés early in July.

The Rogers Typograph Company, of New Jersey, and the Electric Typograph Company, of West Virginia, have combined. The new company will be known as the Rogers Typographic Company, with headquarters and shops at Detroit, Mich.

The New Bedford Gas and Electric Light Company, of New Bedford, Mass., is to nearly double the size of its present building and increase its capacity in proportion. A building 75 × 75 and two stories high will be erected. Two new engines, one a Greene engine of 600 h. p., will be put in.

The Electric Light Company of Deckertown, N. J., at a recent meeting elected the following officers: President H. D. Van Gaasbeek; vice president, R. A. Linn; secretary, J. W. C. Carber; treasurer, G. W. Kintner. Directors: C. A. Wilson, B. W. Decker, Ora Hardin, R. A. Linn, H. D. Van Gaasbeek.

Chicago, Ill.—The stockholders of the Chicago and Jefferson Suburban Transit Company have increased its capital stock from $1,000,000 to $2,000,000. A petition is before Council asking for an additional franchise in order that the road may be extended north and west further than the first franchise permitted. The intention of the company is to begin letting contracts for works within 60 days.

The Philadelphia, Reading & Pottsville Telephone Company at its recent meeting elected the following officers: President, A. A. McLeod; directors, Geo. de B. Keim, A. J. Antelo, Samuel R. Shipley, James Boyd; secretary, Howard Hancock; treasurer, John Welsh. Geo. D. Stitzel was chairman of the meeting; Howard Hancock, secretary; G. R. Adams and J. J. Mishler, judges.

The San Antonio Light and Power Company, of San Antonio, Cal., held its annual stockholders' meeting last week in Pomona. N. W. Blanchard, Prof. C. G. Baldwin, Dr. M. B. Campbell, T. S. N. Eaton, B. S. Nichols, J. A. Dole and A. W. Burt were elected directors, and the directors elected J. A. Dole, president; Prof. C. G. Baldwin, vice-president; A. W. Burt, secretary and superintendent.

San Jose, Cal.—The annual meeting of the stockholders of the Light and Power Company was held last week. Directors were elected as follows: Amasa Ealon, Uriah Wood, Lloyd Tevis, J. K. Prior, G. H. Roe, Adam Reihl, C. W. Quilty. At the directors' meeting the following officers were elected: President, C. W. Quilty; vice-president, Adam Riehl; secretary, W. W. Gillespie; treasurer, C. T. Ryland.

The Penn Electric Heat Company, of Philadelphia, Pa., at a recent meeting of the stockholders discussed the question of its finances. The gross income for the year just ended was $11,035.05. The question of reducing the capital from $1,000,000 to $100,000 for purpose of saving $900 in taxes was referred to the board of directors. The value of this company's franchise is estimated to be $3,000,000. The following board of directors were elected: Henry Clay, A. S. DeCamp, David H. Lane, Amos R. Little, William F. Patton, C. W. Taylor, James McManes, W. D. Marks and George W. Hill.

Special Correspondence.

NEW YORK NOTES.

ALBANY, June 30, 1892.

Extension of Franchise.—There is talk of the extension of the franchise of the Union Electric Light Company of Lansingburgh and the consequent prospect of a system of street electric lighting.

Manager J. A. Powers, of the Glens Falls, Sandy Hill & Fort Edward Railroad, has appointed A. S. Crabell, formerly assistant superintendent of the Troy & Lansingburg Railroad, superintendent, and John Mahoney assistant superintendent.

The Johnstown and Gloversville Horse Railroad Company has begun an action to prevent the city of Gloversville from interfering with the construction of an electric road on the present roadbed of the horse railroad. The company will make a vigorous fight.

The trustees of the village of Greenbush, Rensselaer county, are still discussing the electric light problem. Proposals for lighting the village streets and public buildings were received from the McDonough Construction Company of New York City and the East Albany Gas Light Company.

Articles of incorporation of the Village Electric Light Company of Greenbush have been filed at the office of the county clerk in Troy. The company is incorporated for fifty years, and the capital stock is $25,000, divided into 250 shares of $100 each. The directors for the ensuing year are: James Pidgeon, James Murphy and Henry A. Conway.

The Albany Railway Company, which now controls the surface roads in Albany, will further extend its lines, it is said. As soon as the new Albany and Bath bridge for which the last legislature granted a franchise is constructed, a belt line street railroad will be put in operation connecting Albany, Greenbush, East Albany and Bath. Tracks are already being laid between Greenbush and Bath. The work on the bridge will not likely be begun this fall.

The Municipal Gas Company, of this city, has absorbed the Albany Electrical Illuminating Company. The basis of consolidation was share for share, although the gas company's stock is quoted at 140, and the illuminating company's at 130. The capital stock of the Municipal Gas Company is $1,500,000, while the capital stock of the Electrical Illuminating Company is $255,000. It is understood that the capital stock of the gas company will be increased by $250,000.

The Albany Railway Company has leased the Watervliet Turnpike and Railroad Company's road for 99 years, and at its last meeting elected the following officers: President, Robert C. Pruyn; vice-president, A. N. Brady; treasurer and general manager, J. W. McNamara; electrician, W. N. Sturgis. The company has just added ten new open cars built by the Gilbert Car Company and mounted on Taylor trucks. It is now equipping the road with a new 72-pound girder rail and is adding one of the largest generators made by the Thomson-Houston company. The motors will shortly be replaced by S. R. G. motors and a change in the car house is contemplated.

R. V. T.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., June 30, 1892.

Mr. Romaine Mace, representative of the Interior Conduit and Insulating Company, made a pleasant call last week.

The Boston Braid Manufacturing Company has removed its office to No. 27 Beach street, Boston, Mass., having found that its old place was not large enough to accommodate the rapidly increasing business.

The Gethins Electrical Manufacturing Company, manufacturer of the Gethins gravity battery, and dealer in primary and secondary batteries, motors and general battery supplies, has just issued a handsome catalogue.

Lynn, Mass.—The work on the new buildings of the Thomson-Houston company is being pushed and brickwork is being laid. The contractors are ahead of time on the work and nearly all the foundations of the several buildings have been laid.

The Storage Battery Street Railway Company is the title of a new corporation, capitalized at $50,000, which proposes to build a road in Cambridge, Mass., from the corner of Mt. Auburn street and Putnam avenue to Mt. Auburn Cemetery and to Fresh Pond.

The Lynn & Boston Company is laying its horse railroad track along New Ocean street, preparatory to making connections with the roadbed at Lewis street and the Eastern avenue extension, when the electric circuit will be complete. Electric cars then will go down the hill to Swampscott line, returning by way of the avenue extension and New Ocean street to the main track.

Hon. J. D. Washburn, Minister Plenipotentiary and Envoy Extraordinary for the United States to Switzerland, will resign his position, and will return home in September. Mr. Washburn's business interests are considerable, and he feels the necessity of some personal supervision. At the annual meeting of the local board of underwriters, several weeks ago, he was elected president, to succeed A. C. Munroe, and it was generally believed that he would not accept the position, but E. P. Ingraham, secretary of the board, has received a letter from Mr. Washburn which accepts the position, stating that he would return in the autumn.

Before the special committee of the Lynn City Council appointed to consider the best means of expending $2,500 in an electrical fountain, as provided for in the bequest of the late William A. Shute, John A. Heinzan, electrical expert, appeared and outlined the plan of a fountain, which will be one of the finest in the country. The plan provides for a fountain with a convex mirror basin 25 feet in diameter. The water will spray from a two-inch pipe, and, descending, will fall through iridescent rays produced by prisms surrounding a 4,000-candle power electric arc light. Rusticity in the general effect is aimed at, and the water will flow into a central reservoir over rocks and grass.

A New Railway in Cambridge.—A new street railway, to be known as the "Storage Battery Street Railway Company," has been formed in Cambridge, with a capital stock of $50,000. This corporation is to construct a railway, beginning at the junction of Putnam avenue and Mt. Auburn street, in Cambridge, and extending through Mt. Auburn street to Mt. Auburn Cemetery. From there the road will run to the Fresh Pond Station on the Watertown branch on the Fitchburg road and thence by other streets to Putnam avenue again. The total length of the road will be between two and three miles and the gauge will be that required by law, four feet eight and one-half inches. The name of the company shows that the road will be an electric one, run on the storage battery system. The directors selected to act until others shall be chosen are Edwin H. Abbott, A. L. Richards, H. O. Houghton, Jr., E. P. Usher, W. I. Jones, Woodward Emery and W. S. Hall.

W. R. W.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, June 30, 1892.

Mr. W. E. J. Deming, inspector of electric wires, Minneapolis, was a Chicago visitor last week.

W. E. Moling, 43½ N. High street, Columbus, O., expects shortly to place the Lechner mining machine again on the market.

Mr. Clifford Holbrook, vice-president of the Canton Steel Roofing Company, Canton, O., called on the Chicago trade this week while en route east from the Pacific Coast.

Mr. W. A. Carroll, manager of the Western office of the *Scientific American*, returned to Chicago this week from a trip through Texas, Arizona, and along the Pacific Slope.

Mr. B. J. Arnold, the consulting engineer of the railway department of the General Electric Company, has also been appointed consulting engineer of the World's Fair Intramural Railway.

The Canton Steel Roofing Company, of Canton, O., have issued their sixteenth annual combined catalogue, reference book and price-list. It contains about 100 pages, and is handsomely illustrated and printed on high grade book paper.

The H. M. Loud & Sons Lumber Company will furnish the octagonal poles used in the line construction of the Fort Wayne and Belle Isle Railway, now being equipped at Detroit, the sale having been effected by C. H. Keating, of Bay City, Mich.

F. DE L.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, June 15, 1892.

Trolley System in Germany.—The Thomson-Houston line belonging to the Bremen Street Railway Company was opened at the beginning of the month.

A Mechanical Science Degree at Cambridge.—The proposal of the authorities of the University of Cambridge to institute a practical mechanical science degree has attracted considerable attention and not a little regret has been expressed that this ancient university should consider it necessary to convert itself into a technical college. Cambridge has hitherto held its own as the home *par excellence* of pure science, and it seems to many in this country that it would be better for it to devote its energies to maintain its reputation in this respect rather than to fall in with the passing mania for commercial science, as contrasted with science pursued for its own sake.

Accident on the City & South London Railway.—On Friday last a second fatal accident occurred on the City & South London line. At the inquest it transpired that a guard asked the deceased and a friend whether they would like to see the engine work, and that the deceased stepped on the engine and disappeared down the opening between carriage and locomotive, with the result that he was run over. It also transpired in the course of the evidence that it is an apparently common custom on this line for the guards to invite members of the public "to see the wheels go round." Although the cause of the accident was of so plain and straightforward a character, several members of the jury were determined in some way to fix the blame on electricity, and were perhaps, satisfied by the statement made by one of the witnesses that the body of the unfortunate man was found to be charred slightly; which, as the live conductor is about 18 inches from one of the bearing rails, is by no means improbable.

Electric Railway Bill.—On Friday last the inquiry of the Select Committee on Electric Railways terminated, three out of the five bills having been reported to the House of Commons. Great efforts were made by the Metropolitan Railway Company to prevent the passage of the Great Northern Railway Company's bill on the grounds that there was no evidence before the committee that electric locomotives were equal to such heavy trains as it was proposed to use on this particular line. Mr. Alexander Siemens, however, who was called in support of this bill, soon disposed of the quibbles of the opponents, making considerable capital out of the contract of the Thomson Houston to run the traffic of the Baltimore & Ohio Railway through the Belt tunnel. There was, he assured the committee, no difficulty in constructing 700 h. p. motors and, therefore, from an engineering point of view, there was no difficulty at all. *The* difficulty was to "get the public to invest their money in them."

Answers to Correspondents.

Readers are invited to send discussions regarding, or answers to the queries published in Inquiries from Correspondents or with regard to any other live questions on electrical subjects. In answering questions please refer to them by their serial number. Correspondence must be accompanied by the real name and address, not necessarily for publication, but as a guarantee of good faith. Names of correspondents will be printed in full unless otherwise requested. All correspondence should be as brief as is consistent with clearness. THE ELECTRICAL WORLD *assumes no responsibility for the opinions expressed by correspondents.*

[6.] The two formulæ mentioned, the one for a tangent galvanometer and the other for a solenoid, cannot be made identical. From the very definition of a solenoid it follows that the field inside is uniform, while it is quite evident that in the tangent galvanometer this is not true, and the strength of the field is very different at the centre from what it is at the circumference. On this subject see an article by Carl Hering on the "Ampère-Centimetre, a Measure of Electro-Magnetism," in THE ELECTRICAL WORLD of May 28, 1892, and the discussion in subsequent issues. W. H.

[101.] If the resistance of a certain portion of circuit is 1,500 ohms and the current is .2 ampère the difference of potential at its terminals would be the product of the two, namely 300 volts. The effect is precisely the same as if that portion of the circuit were isolated and an E. M. F. of 300 volts separately applied to it.

W. H.

[103.] Mr. Fay's diagram was incorrect. See an article on the subject by F. L. O. Wadsworth in THE ELECTRICAL WORLD of Feb 27 and March 12, 1892. D. A. C.

[104.] If the load on a constant current motor is appreciably increased beyond the normal, the motor will be brought to rest. The current will not increase or decrease, as you suggest, because from the very definition the current is constant. H. C.

[105.] If the neutral wire is small a cross on one side would cause the voltage to get higher on the other side. D. E.

[106.] The resistance of one mil foot of copper is about 10.7 ohms and that of 100 feet of the same cross-section will evidently be 1,070 ohms. The drop in volts per circular mil per 100 feet = $1{,}070 \times C$ where C = the current. For any other size, divide by the circular milage. The E. M. F. of the dynamo does not enter the problem. E. G.

[107.] The resistance of German silver is about 12.5 greater than that of copper. The drop in volts per circular mil per foot per ampère is then $= 12.5 \times 10.7$. Note that for two circular mils the resistance is not twice this value, but half of it; divide by the circular mils, not multiply. E. G.

[108.] In an alternating current circuit the heating effect cannot be said to be proportional to the square of the current without stating which current is meant; it is the current represented by the square root of the mean of the squares of all the ordinates of the periodic curve and is equivalent to $\frac{C_0}{\sqrt{2}}$, where C_0 is the maximum current. The square of this multiplied by R will give $\frac{1}{2}C_0^2 R$ which is the expression referred to in your question. L. M.

[110.] The carbon used for dynamo brushes is more homogeneous than that employed for the carbon plates of batteries, and you had better use that specially prepared for the purpose. By no means soak it in oil before plating. H. W.

[111.] "Saturated solution of zinc" means simply a solution, probably the chloride, which is completely saturated with zinc; that is the acid is all used up. C. A. B.

[112.] Connect one terminal of an accumulator or good sized battery to the shaft and the other to one of the brushes resting on the commutator, the other brush being removed; connect also a voltmeter across between these terminal wires. Revolve the armature, and when the short-circuited section is reached the voltmeter will read zero or very nearly so. A low resistance bell might perhaps work in place of the voltmeter if the armature resistance was not too low. In this case the bell would cease to ring when the short circuit was reached. Instead of a battery it might be more convenient to use a current from the mains or from another dynamo, being careful to place a batch of lamps in circuit to prevent short circuiting. C. H.

[113.] You cannot connect your 110-volt four pole dynamo so that it will give 220 volts during the day. This would involve a radical change in the winding of the armature and one which could not be made daily. C. D.

[114.] Your question is too general. A. B.

[115.] In your question as to what should be the dimensions of the wire coils for the tangent galvanometer to give it a wider range, I presume that you mean to enable it to measure larger currents. Wind over the fine coils two turns of No. 4 B. & S., bringing out the ends so that they may be joined either in series or parallel. If this does not give sufficient range then try, instead, a heavy copper strip just wide enough to go into the frame. L. B.

[117.] An objection which would prohibit the use of aluminium springs in a storage battery is the fact that aluminium dissolves at the positive plate. C. H.

[118.] See "Practical Electric Bell Fitting," by Allsop.

A. B.

[119.] The usual alloy for storage battery plates is lead and antimony. The Julien company claims to use mercury in addition to these. H. D.

News of the Week.

THE TELEPHONE.

Stillwater, Minn.—A telephone line has been constructed between this place and North St. Paul.

Princess Anne, Md.—A telephone line is being constructed to connect Deal's Island with this place.

Sandy Point, N. J.—Another telephone cable has been laid across the Raritan River at this point, making three cables in all.

Springfield, Mass.—The New England Telegraph and Tele-

phone Company has asked the City Council to pass an ordinance that will allow electric wires to be laid in underground conduits, and the company promises to adopt that system as fast as it is possible.

A Blind Operator.—The Bell Telephone Exchange, of St. Louis, has now in its service a blind operator. His name is Charles E. Reavey, and he is 26 years of age. He was recently employed in Philadelphia in similar work, and can work a switchboard as rapidly and skillfully as if his sight were perfect. The Philadelph a exchange still has two blind operators on its force.

THE ELECTRIC LIGHT.

Adel, Ia., will issue $10,000 bonds for the erection of an electric light plant.

Aspen, Colo.—The Consumers' Electric Light Company will immediately erect a plant.

Rockport, Mo., has issued $12,000 for the purpose of building water and electric light works.

Hendersonville, N. C.—Howell Cobb has contracted for an electric light plant for his hotel.

The Mascoma Flannel Mill, of Lebanon, N. H., is being equipped with 600 incandescent lights.

Alexandria, La.—The Red River Oil Company will put in an electric light plant for lighting the new mill.

The Carondelet Gas Light Company, of St. Louis, Mo., contemplates the erection of an electric light plant.

Doylestown, Pa.—The commissioners on lamps and lights will receive bids for the lighting of the town with electricity.

The Marion Steam Shovel Company, of Marion, O., is to equip its works with a complete electric light and power plant.

Quincy, Ill.—The committee on lights recommend the purchase of 100 globes and the establishing of $90) worth of new lights.

The Mobile Electric Light and Power Company, of Mobile, Ala., has contracted for Westinghouse dynamos of a total capacity of 3,000 lights.

The Sheboygan Electric Light Company, of Sheboygan, Wis., has given an order for $20,000 worth of electrical machinery, to be placed in position by July 15.

Elmira, N. Y.—The Electric Light Company contemplates making its capital stock $35,000, and adding another incandescent dynamo to its plant in the near future.

Savannah, Mo.—The City Council has let the electric light contract to the General Electric Company. The contract for erecting the building has been let to W. D. Clark.

Lucerne, Minn.—The City Council has decided to proceed at once to put in an electric light plant. It is understood that the cost of the plant will be defrayed by direct tax.

Westport, Mo.—The Grand Avenue Cable Company has agreed to permit the city to place two dynamos in the power house for the purpose of furnishing the city with lights.

Edgewater, N. Y.—The contract for lighting the streets of the village has been awarded to the Richmond Light, Heat and Power Company, through the influence of Erastus Wiman.

Rockport, Ind.—Fire destroyed the Electric Light and Water Works building at Rockport, and the machinery is unfit for further use. The loss is reported as $6,000, with $2,500 insurance.

Sharpsburg, Pa., has voted to increase the borough debt $15,000, the money to be expended in enlarging the electric light plant and adding the incandescent system to the arc light outfit.

Deadwood, S. Dak.—The Black Hills Electric Light Company has issued $20,000 first-mortgage] bonds] to provide for the erection of a new power-house and increasing and improving system.

Iowa Falls, Ia.—The city has granted a franchise to a company to operate a system of electric lights in the city. The station will have about 1,000 h. p. in engines. Climax boilers will be used.

The Worcester Electric Light Company has just put in a 600 h. p. Corliss engine with shafting, etc., for use in an emergency. A new 2,000 light incandescent and two new arc machines are to be added.

Charlotte, N. C.—D. A. Tompkins and J. R. Gordon, of the Westinghouse Electric Company, have purchased the Marshall, Tex., electric and gas plant, and will equip and operate both plants.

Poughkeepsie, N. Y.—The Poughkeepsie Electric Light and Power Company is about to build a new car house. It will contain two condensing tandem engines of 750 h. p. each, and three 220 h.p. boilers.

Salt Lake City, Utah.—A proposition has been made to the Salt Lake Power, Light and Heating Company by the residents and owners of property in the Thorndyke addition to extend its lights to that place.

Pittsburgh, Pa.—The H. C. Frick Coke Company has made several experiments with electric lights in its mines, and is now considering the advisability of erecting an electric light plant at each of its shafts.

Marblehead, Mass.—A special town meeting has been held in Marblehead to vote on the acceptance of the act of the Legislature of 1891, enabling cities and towns to manufacture and distribute electricity or gas, the vote resulting, yes, 231; no, 8.

Ashland, Pa.—A new electric light company has organized in the Mahanoy Valley to be known as the Merchants' Electric Light Company. The new company will supply arc and incandescent lights to Girardville, William Penn, Shenandoah and Mahanoy City.

Taunton, Mass.—When the new alternating machine was started for the first time at the electric light works the belt broke and tore up nearly the whole length of the dynamo room and knocked out part of one end of the building. The damage is estimated at $1,000.

Detroit, Mich.—The Park and Boulevard Commissioners are in favor of establishing a complete electric light system at Belle Isle Park. Plans will be prepared for a plant constructed in such a manner that it can be added to and eventually used for water supply purposes for the island.

Worcester, Mass.—H. H. Bigelow has received permission from the board of aldermen to proceed with the formation of his electric light company. His plant will be located near the Worcester & Shrewsbury Railroad, and will be 120 × 150 and 900 feet long. Mr. Bigelow proposes to light along the lake if he is given authority by the commissioners.

Lansing, Mich.—Prof. J. F. McElroy, superintendent of the State School for the Blind, has brought out a new process for the lighting of trains by electricity. A dynamo weighing only 300 pounds, and thoroughly protected, is attached to the forward axle of the locomotive. Storage batteries are used when the train is not in motion. An electric headlight is part of the equipment.

Rochester, N. Y.—At the next meeting of Common Council the question will be considered of placing electric wires underground on Main and State streets in accordance with the agreement between the city and the companies. The matter will be referred to the electrical committee and they will advertise for bids for the construction of conduits to be owned by the city and rented by the companies.

THE ELECTRIC RAILWAY.

The Waterville & Fairfield, Me., street car line is soon to be operated by electricity.

The Mobile Electric Railway Company is to put in both Westinghouse and Thomson-Houston apparatus.

York, Pa.—The ordinance granting the street railway company the right to construct a double track on Market street has been approved.

Cleveland, O.—The City Cable company has an ordinance before the City Council to secure the privilege of equipping its St. Clair street line with electricity.

The Trumble Electric Company, of Warren, O., owns the right of way between Warren and Niles, and proposes to proceed at once to build a road between those points.

The Wakefield & Stoneham Street Railway Company has contracted with the Westinghouse Electric and Manufacturing Company for four car equipments for its road, which will be in operation Aug. 1.

New Haven, Conn.—Chas. A. Warren, vice-president of the State Street Horse Railway Company, states that electricity as a motive power will soon be adopted if the West Haven road finds the system successful.

The Cayadutta Electric Railway Company has leased offices in the Windsor Hotel building, which are being fitted for occupancy. The managers say that work will be commenced as soon as the contracts can be drawn up and let.

Ottumwa, Ia.—The Ottumwa Electric Street Railway Company sold $100,000 bonds at par to Lamprecht & Bros., of Cleveland and Boston. This insures a new electric line of two miles in South Ottumwa, with a double capacity of the plant.

Glenwood, Pa.—The Second Avenue Railway Company, which has purchased the Braddock & Turtle Creek Electric Railway, of Pittsburgh, has purchased land at this place and will erect a power house at Brady street and Second avenue.

LEGAL NOTES.

Boston, Mass.—The full bench of the Supreme Court has sent down a decision in the case of the Attorney General vs. the Walworth Light and Power Company, ordering an injunction to issue against the defendant to restrain the defendant from maintaining or using certain electric wires for electric lighting purposes.

Baltimore, Md.—In the case of the American Bell Telephone Company against the Viaduct Manufacturing Company, A. G. Davis, president; and of the Western Electric Company against the same defendants, Judge Morris has signed decrees making the injunction perpetual in restraining the defendant from any infringement whatsoever of the patent rights of the complainant, who in turn waive any accounting and all damages they may have sustained, the defendant being only required to pay costs.

PERSONALS.

Mr. Irving Hale, of the Denver office of the Edison General Electric Company, was in New York last week, and returned to Denver on the 1st inst.

Mr. Carl Hering was married in New York City on June 30 to Miss Harriet B. Truesdell, of Philadelphia, the daughter of Mr. Chas. Truesdell, engineer in the U. S. Army. Mr. and Mrs. Hering will spend part of the summer in Switzerland touring in the Alps.

MISCELLANEOUS NOTES.

The Franklin Experimental Club, of Newark, at a regular meeting held Tuesday, June 21, decided to discontinue its meetings during the summer months. The next regular meeting will be held Tuesday, Sept. 13. The laboratory and reading room will remain open for the benefit of members.

Waterloo, Ont.—The new building of the Bell Electric Light Company will be completed at an early date. The main building is 24 × 36 feet, boiler house 16 × 24 feet. It will be furnished with a 50 h. p. engine and boiler. The dynamo will have a capacity of 60 arc lamps. The company is putting in all modern improvements.

Asbury Park, N. J., is going to introduce an electric fire alarm. An appropriation has been made for this purpose. H. C. Marryott, chairman of the fire and water committee of the council, has charge of the subject, and is now inquiring into the cost of the various systems of apparatus necessary for a plan of this kind.

The American Street Railway Association has just issued a verbatim report of its tenth annual meeting held at Pittsburgh Oct. 21 and 22, 1891. It contains besides the full report of the proceedings an engraved portrait of Mr. Henry M. Watson, president of the association, and a complete list of members and officers, corrected up to Feb. 1, 1892.

A Rheostat for Medical Use.—Dr. John L. Gish, of South Bend, Ind., has devised a rheostat for use in connection with medical electrical apparatus. A company has been formed called the John L. Gish Ideal Rheostat Company for the manufacture of the apparatus. Col. C. H. Bennett is the president, Dr. J. L. Gish vice-president, and C. H. Smith secretary.

The Weekly Bulletin of Periodical and Newspaper Literature is published at 5 Somerset street, Boston, Mass., and a recent issue contains a classified index of 1,300 articles from recent numbers of periodical journals. The *Bulletin* catalogues the important articles in the leading daily and weekly papers and the monthly magazines of the United States and Canada. Articles from THE ELECTRICAL WORLD are regularly indexed in its columns.

The University of Minnesota has issued its annual catalogue. It contains considerable interesting matter on the various departments, which include science, literature and the arts, engineering, metallurgy and the mechanic arts, agriculture, law, medicine and the graduate department. The course in electrical engineering is very complete. The laboratories are well equipped, and an excellent course in the theory and practice of electricity is laid down. The numerous plants in Minneapolis and the neighboring cities give opportunities for practical testing.

The electrical equipment of Tulane University, of New Orleans, La., is well shown by two handsome photographs which we have received from Prof. Brown Ayres, of the department of Physics and Electrical Engineering of that institution. The photographs show two interior views of the laboratory. Among the machines we notice an Edison arc light machine, a Thomson-Houston arc machine, a Slattery alternator, a Wood arc dynamo, four or five small Edison incandescent machines and motors of the Sprague, Perret and Edison types. The photograph of the instrument room shows a number of galvanometers of different types and a good stock of miscellaneous apparatus for the use of students, including ammeters, voltmeters, resistance boxes, etc.

Industrial and Trade Notes.

The H. M. Loud & Sons Lumber Company is furnishing the octagonal poles for the Fort Wayne & Belle Isle electric road at Detroit.

The Campbell and Tell Company, of Baltimore, Ind., send us a note to the effect that Mr. Robert R. Tell is no longer connected with the active management of the company.

The Campbell & Zell Company, of Baltimore, Md., has been awarded the contract for a 250-h. p. Zell improved water tube safety boiler, by Messrs. Badenoch Bros., Chicago, Ill.

The Ohio Machine Tool Works, of Cincinnati, O., is issuing an illustrated circular describing its special patent motor gear lathe, which sets forth all the good points of this machine.

The Quaker City Electric Company, of Philadelphia, is issuing an attractive little catalogue. It describes its incandescent dynamo, switchboard, etc., and contains some excellent testimonials.

The International Okonite Company, Ltd., has sent us two neat little souvenirs in the form of match boxes, very handsomely nickel plated. On the cover is stamped the well known Okonite trade mark.

The Mason Regulator Company, of Boston, has secured from the Consolidated Car Heating Company an order for 500 locomotive reducing valves, which is the largest single order ever received for reducing valves.

Mr. N. L. Schloss, who formerly represented Thos. H. Dallet & Co., of Philadelphia, in New York City, will hereafter act as general agent of the Ries Electric Specialty Company, of Baltimore, for New York and New England.

W. H. Lahman, 154 Lake street, Chicago, has issued a neat pamphlet setting forth the many advantages of the Lahman-Kirkwood patent fuel saving, shaking and dumping grate bar. This bar is especially adapted for electric light plants, and a large saving is claiming. A very large list of references is given.

The Berlin Iron Bridge Company, of East Berlin, Conn., is now building a new machine shop for The Solvay Process Company, at Syracuse, N. Y. The building will be 50 feet wide by 300 feet long, and three stories high The side walls will be of iron and brick (combination construction) with iron floors and iron roof covered with the Berlin Company's Patent Anti-Condensation Roofing.

The Watertown Steam Engine Company, of Watertown, N. Y., is sending out an illustrated catalogue descriptive of its engines and boilers. Besides the well known automatic engines this company manufactures the Excelsior Straight Line engine, the Excelsior engine, portable detached, agricultural and traction engines, besides various forms of boilers. It also makes circular saw mills of different sizes.

The E. W. Bliss Company, Limited, and the Stiles & Parker Press Company have issued a very substantial and complete catalogue. It contains descriptions of all the presses, dies and machines manufactured by these companies. The illustrations are very profuse and enable the purchaser to see exactly what he is getting. The great number of different forms of presses is especially noticeable. The catalogue is an excellent one.

The Stirling Company, through its Boston agent, J. Bradford Sargent, has secured the following orders during the past month, in addition to a number of small units: Excelsior Electric Company, Port Huron, Mich., 250 h. p.; The International Nickel Mining Company, Ore., 300 h. p.; The South Chicago Railway Company, 1,000 h. p.; Soldier's Home, Leavenworth, Kan., 600 h. p.; West Superior Iron and Steel Company, West Superior, Wis., 600 h. p.; Schumacher Milling Company, Akron, O., 400 h. p.

The M. C. Bullock Manufacturing Company, of Chicago, has secured the order for a 250-h. p. Bullock-Corliss engine, three 100-h. p. steel boilers, together with jack shaft and friction clutch pulleys, for the power plant of the Belle City Street Railway Company, Racine, Wis. It will also do the erecting, and turn the plant over to the company under steam. In addition to the above the past week has brought the company orders for a 250-h. p. Corliss to go to Logansport, Ind., and a 350-h. p. engine for the works of Wm. Deering & Co. It has also received orders from New York City for seven large friction clutch pulleys fitted with its friction device.

The Ball Engine Company, Erie, Pa., reports the following as a few of the shipments during the last four weeks: H. Ward Leonard & Co., New York City, one 130 h. p.; Electric Light Company, Coulee City, Wash., one 25 h. p.; Silver Bow Electric Company, Butte, Mont., one 150 h. p. tandem; Hotel St. Louis, Minnetonka, Minn., one 60 h. p.; Oakland Street Railway Company, Stockton, Cal., three 200 h. p. tandems; Edison General Electric Company, Joplin, Mo., one 35 h. p.; Baltimore Traction Company, Baltimore, Md., two 130 h. p.; Hotel Vendig, Philadelphia, Pa., one 50 h. p.; Schuylkill Electric Railway Company, Pottsville, Pa., one 300 h. p.; Rome Street Railway Company, Rome, Ga., one 130 h. p., two 100 h. p.; Duluth Street Railway Company, Duluth, Minn., one 50 h. p.

The Ball Engine Company, Erie, Pa., less than a year ago, owing to the great expansion of it business, was forced to erect a large machine shop, which was filled with the most modern improved tools. No idea was entertained at the time that any further increase would be necessary for several years to come, but the demand for the latest improved Ball engines, built by this company, has been so great, especially for electric railway work, that already the makers of the engine have been again compelled to make a further extension of the same building. This extension, which is now under way, will be built on the gallery plan, the same as the rest of the building. It will contain, among other features, the most complete testing blocks and apparatus in the country, and will be capable of testing engines of very large capacity.

The New Jersey Lamp and Bronze Works, of Brunswick, N. J., has opened a branch office at 44 Murray street., New York, which will be used as an exhibiting department and will be known as the electro and gas fixture department. Until recently this company confined itself to the lamp and gas fixture trade, although it had received large contracts from some of the large electric companies for material used in the electric trade. It now intends to manufacture all kinds of electric and gas chandeliers, brackets, hall light, decorative bronze electric fixtures, sockets, switches, etc. The factory is running at full capacity with over 300 men employed in the lamp and gas fixture department, and 100 in the electric fixture department. Mr. Ralph W. Booth is general manager of the company, and Mr. G. Wilfred Pearce, acting superintendent of the electric fixture department.

The Brady Manufacturing Company, 83 and 85 South Washington street, Brooklyn, is perhaps little known to the general

public, as it has never been the policy of the company to advertise, but its name and the quality of its work is familiar to government contractors and to the many companies which have had dealings with it. The factory is equipped with the very highest grade of machinery and the company manufactures nearly all the tools used, so that it is well fitted to do special work. There are facilities for handling work weighing from one pound up to 20 tons. The factory employs over 200 hands and is run to its full capacity. The company is now under contract with the United States Pneumatic Dynamite Gun Company and is perfecting the shells for this gun, which requires some fine work. It also has the full contract for making the Williams typewriter. The long engineering experience of Mr. Brady himself well fits him for the work in which he is now engaged.

W. R. Fleming & Co., Mail and Express Building, New York City, agents for the Harrisburg Foundry and Machine Works, report the following as a few of the contracts made by that company alone during the past few weeks. It should be remembered that these sales cover only the portion of the country reached from the New York office, and do not consider the sales made by the factory or the other agencies: The Edison Electric Light Company, North Plainfield, N. J., one 20 h. p. standard Ideal engine and 150 h. p. steel horizontal boiler; Mail and Express Building, New York City, four 100 h. p. special direct-connected Ideal engines; steam yacht Clarion, Newport, R. I., one 16 h. p standard Ideal boiler; Naval Observatory, Washington, D. C., one 30 h. p. and one 50 h. p. standard Ideal engine; Brazil, one 55 h p. standard Ideal engine and one steel horizontal tubular boiler; Century Club, New York City, one 55 h. p. and one 60 h. p. standard Ideal engine; Chillicothe Street Railway and Lighting Company, Chillicothe, O., one 150 h. p. and one 80 h. p. special railway Ideal engine and one 55 h. p standard Ideal engine.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Burlington Route—New Service.—A through Pullman sleeping car, Chicago to San Francisco, is a feature of the Burlington's new service. This car leaves Chicago daily on the fast train at 1:00 P. M., and runs via Denver, Colorado Springs, Leadville, Glenwood Springs, Salt Lake City and Ogden, arriving in San Francisco at 11:45 A. M., less than four days *en route*.

Pullman Vestibuled Buffet Sleeping Car Service—Chicago to Portland, Me.—Commencing June 26, and continuing through the tourist season, the Chicago & Grand Trunk Railway will run a Pullman vestibuled buffet sleeping car of the most modern pattern, through without change, from Chicago to Portland, via Toronto and Montreal, leaving Chicago 3 P. M. daily except Saturday, arriving at Portland for breakfast second morning. On this train there will be a Pullman car for Old Orchard Beach, and tourists for all North Atlantic seaside and mountain resorts will find this improved through service worthy of patronage. Secure sleeping car reservations and further information by applying to E. H. Hughes, General Western Passenger Agent, No. 103 S. Clark street, Chicago.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

U. S. PATENTS ISSUED JUNE 28, 1892.

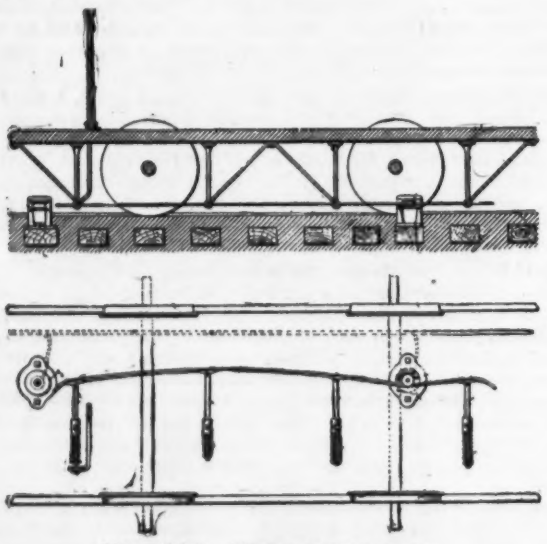
11,250, Re-issue. Electrical Measuring Instrument; Edward Weston, Newark, N. J. Application for re-issue dated Feb. 5, 1892. In an electrical measuring instrument, a stationary coil, a coil movable in the field of the stationary coil, and a spring opposing and counterbalancing the impressed action of the movable coil, the coils and spring being connected in circuit.

477,635. Electrical Keyboard; William E. Blodgett, Faribault, Minn. Application filed March 17, 1890. The combination, with a series of keys or levers, of an initial contact point, initial circuit closers connected with a suitable battery and adapted to be brought in contact with the initial contact point by the operation of one of the keys or levers, secondary contact points for each of the other keys or levers, all connected with said initial contact point, secondary circuit closers adapted to be brought in contact with the secondary contact points by operating the keys or levers and independent partial electrical circuits connected with the secondary circuit closers and each having a battery connection.

477,637. Electric Regulating Apparatus; Julien M. Bradford, Portland, Me. Application filed Sept. 29, 1890. In a current regulator, the combination of a brush-shifter or current varying device, regulating devices arranged to move the brush shifter in one direction, mechanism responsive to incipient increase and decrease of line current for controlling the regulating devices, a traction device attached to the brush shifter to move it in the opposite direction, and auxiliary means operating independently of variations of line current to cause the brush shifter to be moved progressively to positions where sufficient current will be taken up.

477,645. Battery; William A. Childs, Englewood, N. J. Application filed Dec. 27, 1888. In a battery, a metal screw bolt or rod having a carbon head, the bolt or rod passing upward through an opening in the negative element and through the battery cover.

477,652. Writing-Telegraph System; Harry Etheridge, Pittsburgh, Pa. Application filed Sept. 10, 1890. The combination, with a number of autographic-telegraph instruments arranged in series on two circuits, both of which are normally broken, of two automatically and consecutively acting circuit-closing means arranged one in each circuit for closing the two circuits.



No. 477,734. ELECTRIC RAILWAY.

477,656. Lightning Arrester; Frederic Haselwander, Frankfort, Germany. Application filed Oct. 2, 1891. The combination, with an automatic circuit-breaker, having circuit terminals and an earth connection, of an explosive cartridge interposed between the terminals and the earth connection, and a conductor upon the cartridge through which the circuit is completed.

477,665. Individualizing Cut-Out for Printing Telegraphs; Samuel Rush Linville, Philadelphia, Pa. Application filed Feb. 10, 1892. An individualizing cut-out system for printing telegraphs comprising a line, means for transmitting normal and abnormal electric currents, and a series of receiving instruments included in the line and each provided with a type-wheel shaft operating to cut out magnets and include individualizing line cut-out mechanism and with electrical devices responding to abnormal line currents and operating the individualizing cut-out devices to include and exclude the required instrument or instruments.

477,708. Electric Current Regulator; Charles Dwight Sigsbee, Thomas S. Hayward and Frank S. Anderson, Easton, Md. Application filed Sept. 11, 1891. A resistance device or mass of compound structure for electric currents composed of electric conductive material arranged in alternate layers with one or more perforated regulating plates of lower conductivity.

477,712. Automatic Test for Burglar Alarm Systems; Alfred Stromberg, Chicago, Ill. Application filed March 17, 1892. In an automatic alarm system, the combination, with a normally closed metallic circuit through the district to be protected, of a resistance connected between the two sides of the metallic circuit, a periodical contact closing mechanism adapted to temporarily short-circuit the resistance, central office apparatus adapted to respond to changes of the condition of the district circuit resulting from the opening, grounding or crossing of the circuit through the district, and recording apparatus adapted to respond only upon the operation of the periodical contact closing mechanism.

477,729. Dynamo-Electric Machine; James J. Wood, Fort Wayne, Ind. Application filed Dec. 1, 1891. In a dynamo or motor, the combination of the commutator brush yoke and the adjacent bearing, the one formed with a concentric cylindrically projecting flange and the other with a corresponding groove embracing the flange, and a fastening applied to hold the parts together and prevent the disengagement of the groove and flange.

477,732. Method of Insulating Electric Conductors, Arthur V. Abbott, Closter, N. J. Application filed March 12, 1892. In the construction of electrical apparatus or machinery, the method of insulating the wire or other parts, consisting in applying one or more coats of a vitreous enamel, holding the same in place by a wrapper of organic substance, and vitrifying the enamel and destroying the organic material by firing.

477,734. Electric Railway; Joseph W. Bates, Minneapolis, Minn. Application filed March 17, 1892. The combination, with the track and the car to run thereon, of a series of posts projecting above the surface of the roadbed and having slotted openings, contact rollers or pulleys insulated from the posts and arranged in the openings, a feed wire connecting with each of the pulleys, and a flexible contact cable carried upon the car and adapted to successively engage the several contact pulleys. (See illustration.)

477,753. Insulator; Frederick D'A. Goold, New York. Application filed Oct. 24, 1891. The combination of a support, a hanger on the support, having at its lower end a spring holder, and an insulating body in and clamped by the holder, having a passage through it for the reception of a wire to be supported.

No. 478,018. ELECTRODE FOR SECONDARY BATTERIES.

477,781. Device for Suspending Trolley Wires; Joseph Sachs, New York. Application filed Oct. 28, 1891. In a wire-supporting device, of a body with a dovetail socket or recess, the narrow, open side of which faces downward, and corresponding wedge clamping-plates in the same and adapted to clamp a wire, whereby the weight of the wire tends to force the clamping plates together.

477,786. Socket for Incandescent Lamps; Evelyn L. Smith and George C. H. Foster, Bridgeport, Conn. Application filed Sept. 7, 1891. In a socket for incandescent lamps, the combination of the upper and lower insulating-discs having secured thereto, respectively, the usual terminals, the yoke to which the discs are secured, the socket-screw secured to the bridge of the yoke, the contact-springs secured, respectively, to said screw and the lower terminal, the rotary stem journaled in the yoke, and the cam carried by the stem.

477,787. Electric Conductor; Charles T. Snedekor, Worcester, Mass. Application filed Oct. 17, 1891. In an insulated electric conductor, the combination, with a metallic conductor, of a fireproof compound consisting of calcined magnesia, china-clay, and silicate of soda applied to the metallic conductor, of a coating consisting of a compound of rubber applied to the fire proof compound and a second fireproof compound applied directly to said rubber compound.

477,810. Receptacle for Portable Electric Lamps; Herrman Molendo, New York. Application filed April 21, 1892. A receptacle for portable electric lamps, composed of a base, parallel blocks attached to said base, and metallic angle pieces attached to the base and extending over the inner faces of the blocks, the angle pieces being connected with the conducting wires at their outer ends and provided at their inner ends with pivots arranged in line with each other.

477,845. Phonoporic Telegraphy; Charles Langdon, London, England. Application filed April 20, 1892. A phonopore-transmitter comprising primary and secondary coils, a battery, a vibrator, a primary circuit in which the battery is included and which includes the primary coils, an open secondary or phonopore circuit, of which the secondary coils form a part, a key for opening and closing the primary circuit, and means for closing a circuit through the primary coils when the key is not in use to open and close the primary circuit.

477,866. Telephony; Robert Hope-Jones, Birkenhead, England. Application filed Sept. 17, 1891. In an apparatus for magnifying minute vibrations or impulses, the combination of an electric conductor moving in a constant direction, a magnetic field varying as the vibrations or impulses to be magnified, and opposing to the movement of the conductor correspondingly varying amounts of electromagnetic retardation, a body capable of vibrating as described, and means whereby there is applied to said vibratory body successive portions of the motive power of the conductor varying in accordance with the power absorbed in overcoming the varying amounts of retardation.

477,869. Electric Switch; Herbert M. Pilkington and Roger S. White, Brooklyn, N. Y. Application filed Oct. 8, 1891. The combination in a switch of several switch-blades or members movable both together and independently and having a co-operating handle and separate handles for operating said members.

477,870. Anti-Inactive Device for Telephones; Simon Poliak, Prague, Austria-Hungary. Application filed Nov. 11, 1891. The combination, with a telephone transmitter and its coil on an induction circuit connected with the receiver, a telephone transmitter on a line circuit, and a coil on the line circuit, both of the coils being movable and adapted and arranged to be brought into and out of alignment with each other to any desired degree.

477,879. Electric Current Transformer; Norman T. Wilcox, Meriden, Conn. Application filed Aug. 20, 1891. The combination of a direct current generator, a direct current motor, a transformer and collecting rings, to which one of the windings of the transformer is connected, with a single commutator having opposite segments connected to the collecting rings, and serving also to commute the current flowing through one part of the motor. (See illustration.)

477,890. Mast-Arm Electric Switch; Thomas Dillon, Indianapolis, Ind. Application filed March 31, 1892. In an electric switch for electric light mast-arms the combination with a pair of line circuit terminals arranged adjacent to the axis of the mast-arm and the pair of lamp circuit terminals arranged on the mast-arm, so as to be projected between the line circuit terminals by the upward movement of the mast-arm, of the metallic point arranged between the lamp circuit and the line-circuit terminals, whereby the lamp circuit is protected from induced currents.

477,897. Electric Lock; William H. Hollar, Elizabeth, N. J., and Frederick A. Holmes, Malden, Mass. Application filed Feb. 3, 1890, in an apparatus for controlling an electrically actuated combination lock, a commutator or break wheel, and a co-operating pen or wiper, and a propelling mechanism for the break wheel, combined with a pole changer to automatically alternately make and break an electric circuit.

477,898. Electric Lock; William H. Hollar, Elizabeth, N. J., and Frederick A. Holmes, Malden, Mass. Application filed Feb. 3, 1890. In an electrically actuated combination lock, a series of tumblers loosely connected, a bolt-locking device or lever operatively controlled by the tumblers, a single ratchet wheel controlling the tumblers, combined with an electro-magnet, its armature and a pawl or pawls to operate the ratchet wheel.

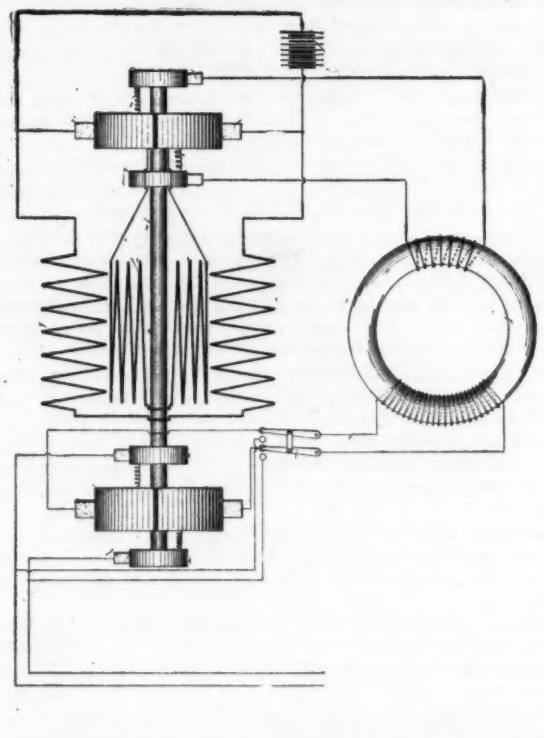
477,913. Voltaic Body Battery; Wilson F. Potter, Albany, N. Y. Application filed April 4, 1892. A voltaic body battery consisting of two or more plates, each plate having ears on its edge or periphery and spaces between the ears, and when the plates are placed together the ears on each plate turned down to overlap a portion of the body of the opposite plate, and thus hold the plates together.

477,914. Secondary Battery; William L. Silvey, Lima, O. Application filed June 15, 1891. In a secondary battery, the combination, with the active plates, of rods for connecting the plates to the external circuit, the rods having a continuous central core, of a metal indestructible in the electrolyte and an outer continuous envelope cast around it, having a screw thread on its surface and nuts.

477,931. Telephone Tablet; Joseph S. Gold, Columbus, O. Application filed Jan. 25, 1892. A tablet comprising a shelf, supported in an inclined position, vertical walls at opposite sides of its upper end, and a vertical partition supported between the walls, with its lower edge slightly separated from the inclined shelf, whereby a roll of paper is placed and supported above the vertical position and passes down through the space between the partition and inclined shelf.

477,940. Pickpocket and Coat-Thief Detector; John F. Hurd, Chicago, Ill. Application filed Oct. 2, 1891. In combination with a garment, an electric circuit, the generator which energizes such circuit, an alarm bell in the circuit, such circuit comprising a circuit making and breaking device secured to the garment, and a flexible partition interposed between the pocket entrance and such circuit making and breaking device and completely obstructing access to the device through the pocket entrance and connected to the circuit making and breaking device and adapted when depressed to operate the same to close the circuit.

477,950. Electric Alarm; Stephen Martin Mathews, Rat Portage, Ontario, Can. Application filed Nov. 16, 1891. An electric alarm, comprising a vertical tube or casing, open at its upper end, closed at its lower end, and provided with apertures through its sides for the water, a cage on the upper end of the tube, brackets or arms connecting its lower end with the boiler flues or tubes, a float within the casing, electric wires entering the bottom of the casing, a spring to connect them when depressed by the fall of the float, and a battery and alarm in the circuit.



No. 477,879. ELECTRIC CURRENT TRANSFORMER.

477,951. Composite Electric Conductor; Charles A. Mezger, Brooklyn, N. Y. Application filed Oct. 30, 1891. A composite electric conductor made in sections, each section comprising two concentric conductor mediums that are tubular, a solid centre conductor and intermediate insulating material that separates the conductors, threaded connections for the sections.

477,975. Electric Bath Apparatus; Henry E. Waite, New York. Application filed May 17, 1892. An electric bath apparatus comprising an inclosing case, an insulated support within the case, a chair for the patient, and a series of rings having inwardly projecting teeth arranged to surround the patient and connections between the rings and an influence machine.

477,980. Insulator; Herbert C. Wirt, Boston, Mass. Application filed Feb. 21, 1890. The combination, with two line wires, of an insulator having a knob at each end insulated from one another, around which the wires are wound and having a central base portion around which the wires are wound and which are insulated from one another.

477,984. Electric Lamp or Conductor Support; Charles Bell, Stroudsburg, Pa. Application filed March 23, 1892. In an electric lamp or conductor support, the combination of a clip formed of two similar arms pivoted together, curved inward at one end and angled at the other end, and an insulating support adapted to receive the clip and hold it in a closed position.

478,018. Electrode for Secondary Batteries; Harry G. Osburn, Chicago, Ill. Application filed April 7, 1891. An electrode plate for storage batteries formed from a single piece of material and comprising the independent longitudinal slotted receptacles and the thin connecting pliable webs intermediate of the receptacles and between the terminals of the slots. (See illustration.)

478,026. Conduit for Electric Railways; Carl Theodor Heinrich Schwieger, Berlin, Germany. Application filed Sept. 16, 1891. In an electrical railway, the combination, with a subway provided with a slot communicating with the street surface, of two conductors of V-shaped cross section opening oppositely to one another in the same horizontal plane beneath the slot, and a traveling contact-making device electrically connected to the motor upon the car, the same having corresponding V-shaped bearing-surfaces fitting cross-sectionally throughout the contact surfaces of the conductors adapted to centre therein and take up wear evenly throughout.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.